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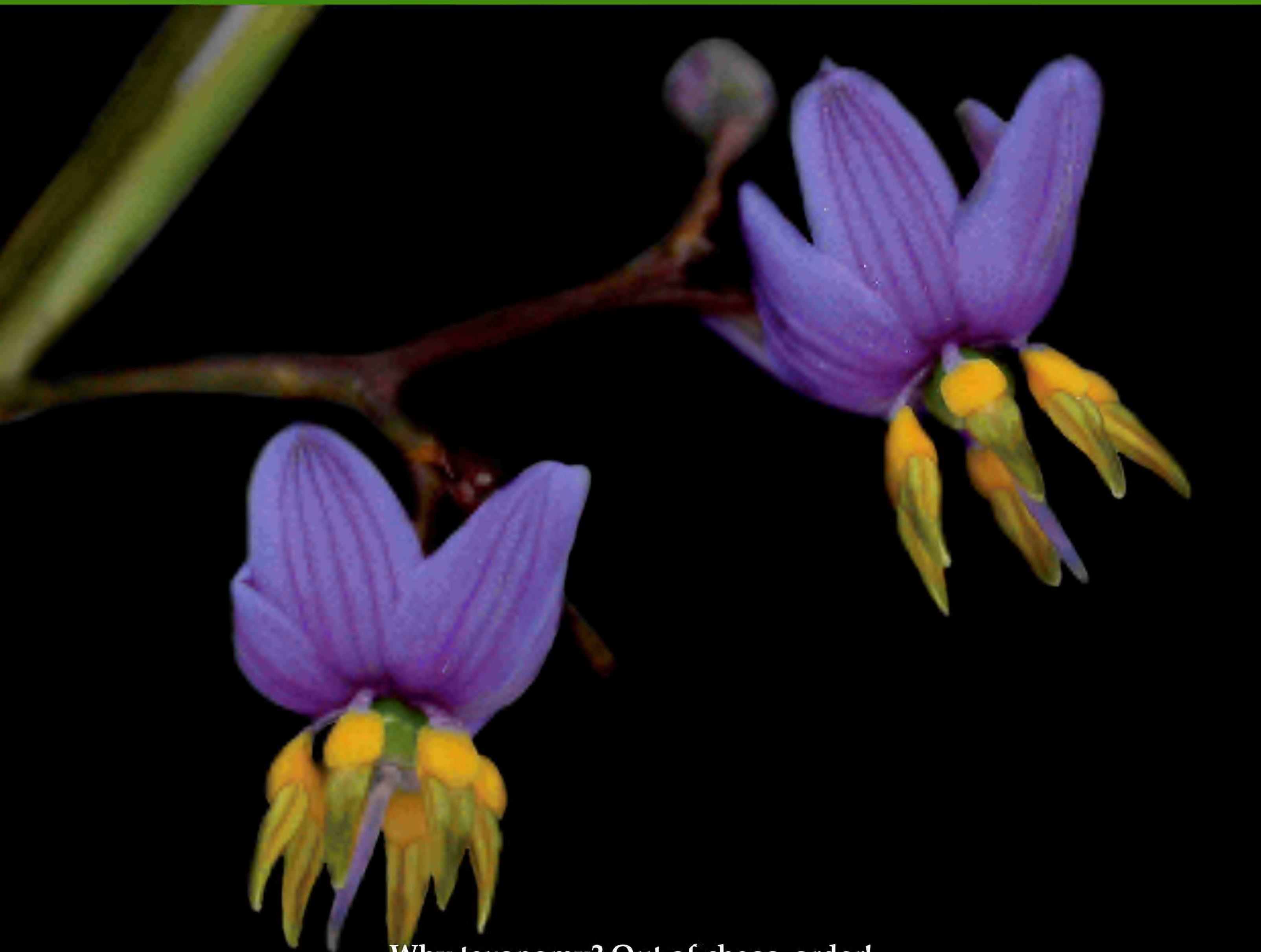

Why taxonomy? Out of chaos, order!
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Dynamics of plant invasions in grasslands: trust your taxonomists
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And much much more………

SPECIAL THEME: TAXONOMY AND PLANT CONSERVATION

President's Report: taxonomy and plant conservation

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Plant conservation and effective biodiversity management largely depend on sound taxonomy. You can't conserve it unless you know it's there, and you have to be able to identify it reliably. The role of taxonomy may not be overtly recognised by many conservation practitioners and land managers, and the underpinning taxonomic knowledge may be taken for granted, just as we have been taking for granted the many services maintained by natural and managed ecosystems. The ANPC has as part of its mandate the linking of outcomes of scientific research to on-ground conservation activities. In this issue of *Australasian Plant Conservation* we endeavour to illustrate how the results of systematic and taxonomic research efforts interact with and contribute to plant conservation.

Legislative recognition

At the international level taxonomy has been recognised as an integral part of plant conservation. The Global Taxonomy Initiative (GTI) (Web ref. 1) was established under the Convention of Biological Diversity (CBD) (Web ref. 2) in recognition of the significant role taxonomic knowledge gaps play in hindering our ability to manage and use the world's biological diversity in a sustainable manner – known as the 'taxonomic impediment'. Further, in 2002 the Global Strategy for Plant Conservation (GSPC) was developed following international concern that inadequate emphasis and resources were being directed towards plant conservation specifically (Web ref. 3). The GSPC has targets set for 2010 relating to current knowledge and arresting the continuing loss of plant diversity (Web ref. 4).

Within Australia, improving our taxonomic knowledge and understanding of the biological diversity of the country was identified as a priority in the National Strategy for the Conservation of Australia's Biological Diversity (Web ref. 5).

This is reiterated and identified as high research priority in the ANZECC and Biological Diversity Advisory Council (BDAC) 2001 identification of Australia's Biodiversity Conservation research priorities (Web ref. 6). While this priority-setting exercise related particularly to threatened species, communities and ecosystems, the underlying necessity of broadscale taxonomic information remains critical.

There is increasing recognition by Commonwealth and State and Territory agencies of the significance of sound taxonomy, particularly in areas relating to governmental controls, such as threatened species legislation, e.g. the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

At both the national and international scale, taxonomy is at the core of species-based legislation in initiatives such as the Convention on International Trade in Endangered Species (CITES), and is an essential element in the nation's effort to maintain effective national quarantine standards.

Taxonomy and Taxonomists

In the past 30 or so years taxonomy (and systematics) has evolved into a 'big picture science', with the status of a modern scientific discipline. In this period there have been massive advances in phylogenetic theory, in computational capability and in our understanding of genetics and evolution, all contributing to levels of sophistication not previously practiced in this field of research.

Many taxonomists working in our universities and herbaria and museums have shaken off the reputation of being sole investigators and now recognise the efficacy of collaboration, undertaking much of their research in small integrated teams. The reality of the political role of taxonomy is acknowledged, together with recognition that the results of research need to be widely and freely available, and easy to access.

In studying any particular group of organisms, taxonomists gather information about the whole biology of the group. Their investigations cover much more than the process of naming species. The science is rigorous and detailed and assimilates information from all aspects of the biological sciences. For instance, in preparing a taxonomic treatment of a plant genus, and attempting to understand the species and relationships within, a taxonomist will incorporate information from a diversity of datasets including morphology, anatomy, chemistry, genome and DNA sequences, pollination and breeding systems, physiology (e.g. C3 or C4 metabolic pathways), ecological and geographic distributions as well as past geological history, in order to formulate sound evolutionary hypotheses and a pragmatic classification. Where individual species are the focus, information on population diversity, genetics and structure may be relevant.

Taxonomy is a dynamic science based on multiple evidence principles and involving a continuous process of incorporating new information. The outcome is new knowledge. The *Flora of Australia* project, a 25-year program of documenting the plant species of the continent, has led to an average 25% increase in the number of species recognised in major genera and families – and many of these newly recognised species are, as you would expect, rare or threatened, and in need of conservation action.

Delivery of taxonomic knowledge

The knowledge accumulated by taxonomic experts is disseminated in various ways and at different levels. In the sense of the CBD or of the Global Environment Facility GEF (Web ref. 7), taxonomy is a means towards implementation, serving conservation and sustainable use.

There are many examples in Australia where taxonomic experts play key roles in threatened species conservation assessment or recovery teams and in other aspects of plant conservation like species-based weed control programs. These coordinated teams of practitioners usually develop highly effective and productive collaborations with relevant and focussed outcomes for plant conservation.

Much of the increasing interest in taxonomy, including that from governments, is driven by the relevance of the data contained in a diversity of electronic resources. Electronic dissemination of information helps to catalyse, support and accelerate collaborative efforts, and to integrate taxonomy into plant conservation practices. The importance of user friendly tools from the taxonomist's kit such as interactive keys based on serious science and with accompanying images, cannot be stressed enough.

Governmental and private industry support for nation-wide on-line databases such as the *Australia's Virtual Herbarium* (AVH) (Web ref. 8) and the *Australian Plant Census* (APC) (Web ref. 9) has enabled taxonomists and biodiversity informatics workers to collaboratively deliver taxonomic information in a readily accessible format via the internet. These initiatives are indeed national activities with consensus views being developed through participation of taxonomists across all States and Territories and the Commonwealth. The integrity of these data becomes increasingly critical as they are applied to studies in conservation biology or GIS analyses of spatial and species data for conservation priority setting.

Recognising the keystone role taxonomy plays in plant conservation is one thing, but Australia's current lack of taxonomic expertise hinders our ability to deliver relevant information at an acceptable rate. The aging workforce and recent concentration on the areas of the biological sciences perceived as being more 'sexy', such as molecular biology, has meant we are currently experiencing a real paucity of taxonomists with expertise on the Australian flora. Key initiatives which will partly address these issues include the National Collaborative Research Infrastructure Strategy (NCRIS - Web ref. 10) supported *Atlas of Living Australia* (ALA) (Web ref. 11), developing the infrastructure for information from taxon names and biological collections data through to genetic and phenotypic information, being freely available via the internet. The Commonwealth Environment Research Facilities (CERF) National Taxonomy Research (Web ref. 12) hub has as its prime objective to increase taxonomic capacity within Australia, and aims to enhance the ability for taxonomists to deliver the results of their research faster, more efficiently and more effectively to a wider range of users, particularly for environmental and conservation benefit.

The articles included in this issue of *Australasian Plant Conservation* provide some explicit examples of the importance of integrating taxonomic knowledge into plant conservation activities. Taxonomists working in partnership with managers of biodiversity for conservation and sustainable use engender a shared sense of purpose and mutual benefit.

References

Web ref. 1. http://www.cbd.int/gti/default.shtml

Web ref. 2. http://www.cbd.int/default.shtml

Webref.3. http://www.cbd.int/programmes/cross-cutting/plant/default.asp

Web ref. 4. http://www.cbd.int/decisions/default.asp?dec=VI/9

Web ref. 5. http://www.environment.gov.au/biodiversity/publications/strategy/index.html

Web ref. 6. http://www.environment.gov.au/biodiversity/publications/research-priorities/index.html

Web. ref. 7. http://www.gefweb.org/

Web ref. 8. http://www.anbg.gov.au/avh.html

Web ref. 9. http://www.anbg.gov.au/chah/apc/index.html

Web ref. 10. http://www.ncris.dest.gov.au/

Web ref. 11. http://www.tdwg.org/activities/bioinformatics-projects/projects-database/view-project/119/

Web ref. 12. http://www.environment.gov.au/programs/cerf/

Why taxonomy? Out of chaos, order!

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Sorting socks in Latin

Even in the most pedestrian aspects of our lives, we tend to classify things. Our socks go in the socks drawer, the shirts hang together in the wardrobe separate from dresses or trousers. Spoons probably all nestle in a compartment beside the forks which lie separately from the knives. Those big clunky kitchen utensils are probably less sorted in a big drawer where we can grab them when needed – but they still have been classified by their use in the kitchen. You certainly wouldn't put them in the dining room sideboard with the fine table linen.

This year has seen the 300th birthday of the king of all classifiers – Carl Linnaeus (the name Carl von Linné came much later, after he had been 'ennobled' by the Swedish king). He was born in Sweden on 13 May or 23 May 1707, depending on which calendar you were using at the time (Wikipedia 2007). One could imagine such imprecision might intrigue someone who is remembered for adding logic and clarity to the whole chaos of the living universe!

Most people working with plants and animals use the Linnaean system of naming organisms whether they know it or not. Without it, we wouldn't be trotting out names such as *Homo sapiens* or *Eucalyptus rossii* or *Pisolithus albus*. Even if someone's scientific education hasn't extended beyond high school, they will probably have learnt about Linnaeus and his contribution to the ordering of the natural world. They may have forgotten it, but they'll still be using it if they ever use a scientific name, wrapping their tongues around those Latin (and Greek) names.

This giving of two names (binomial nomenclature) that together uniquely identify each type of organism is the basis of the Linnaean system. Based on physical similarities and apparent relationships, organisms could be organised into several hierarchical groups, from species, to genus and then to family and so on. But it's the scientific name, that binomial we are all familiar with, that has enabled scientists the world over to communicate.

The methods of determining whether an organism is a unique species have changed, with genetic relationships often over-riding physical similarities, but the Linnaean binomial naming of them remains very much the same. Linnaeus's system was so simple and workable that any modifications since have really just been expansions within the layers of hierarchy.

In addition to introducing binomial nomenclature and synthesising a classification of living things, Linnaeus was also a great teacher. These accomplishments are being celebrated around the world as part of the tercentenary of his birth. In the Resources section (p. 28) are details of special issues of several publications by Botanic Gardens Conservation International that feature the work and legacy of Linnaeus.

Taxonomy and conservation

Research in taxonomy has rarely been high on any Government funding priority list, probably because it's seen as non-applied investigation with outcomes of dubious value. Surely this is knowledge for the sake of knowledge, the dusty realm of an esoteric group of scientists with classification on their minds!

In fact, taxonomy is the tool by which we describe, sort and name organisms so that we can create some order out of an otherwise chaotic assemblage of organisms. It also enables us to recognise if an organism is known ('described') or unknown. As unknown species are described, we accumulate knowledge of species and their relationships. There are many more organisms than have been formally described, particularly in the less-studied groups. For example, there are an estimated 1.5 million fungi in the world, of which only 72,000 have been described (4.8%). Bryophytes fare better, particularly in Australia, with 84% of the estimated 2,200 species now described (Chapman 2005). Even for the better known groups, such as the flowering plants, new native species continue to be discovered around Australia every year.

Good taxonomy is essential to any work that requires an understanding of species and their relationships with other organisms and the environment they live in. Taxonomy provides the language with which we can describe and discuss living organisms.

For some years I worked in the Endangered Species Program of the then Australian Nature Conservation Agency (long-since absorbed into the Commonwealth's environment department, currently the Department of Environment and Water Resources). Decisions to list species as threatened or to fund conservation work were often determined by the taxonomic status of the plants or animals in question.

For example, the Common Brushtail Possum *Trichosurus vulpecula vulpecula*, well-known to suburbanites in the south-eastern states (and now all too well-known to New Zealanders), exists as a few relict populations in rocky outcrops and moist gullies west of Alice Springs. As this possum population is still regarded taxonomically as the same species as its common southern cousin, it has never received Commonwealth funding for research or conservation management nor is it listed on the Commonwealth *Environment Protection and Biodiversity*

Conservation Act 1999 (EPBC Act). Repeated applications for Endangered Species Program funding for this disappearing population failed solely because the species was secure elsewhere.

The Common Brushtail Possum (Central Australian 'subspecies') is now listed as Endangered on the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act), but a recent WWF discussion paper notes that: 'the Central Australian "subspecies" of the brushtail possum … isn't taxonomically a subspecies.' (WWF 2006). Genetic studies aim to create a family tree of Brushtail populations from around Australia; this work should clarify how closely related the long-isolated Central Australian population is to the abundant southern population (Collins 2006).

The Venus-hair fern (*Adiantum capillus-veneris*) also hails from the Northern Territory and is listed as Vulnerable on the TPWC Act but is not listed on the EPBC Act. It occurs as a tiny population in damp crevices in a rocky gorge about 40 km from Alice Springs. The next known population occurs about 1000 km to the north (Peter Latz, pers. comm.). It is unknown whether this is a relict population from moister climate regimes or is possibly derived from wind-blown spores that 'recently' dispersed (NT Government fact sheet 2006). The inverted commas around 'recently' indicate that this could have occurred thousands of years ago – has long-term isolation resulted in any genetic divergence?

The taxonomic status of a species can affect its conservation management and legislative status. This affects government priorities, funding, recovery efforts and scientific endeavour. Inaction based on the view that a declining isolated population is genetically the same as an abundant population elsewhere (and therefore not worthy of conservation effort) could result in local extinctions and loss of biodiversity.

Even if the Central Australian possums prove to fit within the range of genetic diversity of the more abundant southern populations, are they not of value as an integral component of their landscape? Their loss from that landscape through local extinction is a loss of diversity within that landscape and must inevitably result in unknown and probably unpredictable changes to the ecology of an area. Similarly, the loss of a rarely seen fern will deplete the biotic richness of its landscape.

Taxonomy identifies the biotic components of our ecosystems and gives us the language to discuss them. It informs us of their evolutionary history and relationships. Incomplete knowledge of the taxonomy of a species or population can impede conservation managers. However, the use of taxonomy alone to determine conservation action can be deleterious. Taxonomic status can be used to neglect declining populations, if such populations are found to be similar to more abundant populations elsewhere. Taxonomic status should not be the sole basis of decision-making but just one of many tools employed.

More taxonomists needed NOW!

As Ralph Woodford, one of our long-standing members recently pleaded: *There needs to be more funding for the training of taxonomists in all fields ... and we need to make taxonomy something that students want to make a career out of. I have been to several conferences over the past two years and a common ground in all of them has been the lack of classification of our flora and fauna, be it monocots, dicots, fungi, mosses, lichens, insects etc; we only know some of them and to be able to understand their relationships we need to know what we are looking at! Taxonomy is the base building block for the understanding of the environment around us!*

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Have you checked the ANPC website lately?

http://www.anpc.asn.au

We have added participant feedback from workshops (2005 onwards) and the 2007 National Forum as well as evaluation analyses of these events. Evaluation consistently reveals a high level of satisfaction with ANPC workshops. The evaluation forms and participant comments and suggestions also help us to constantly improve our workshops. Also included are the abstracts of papers presented at the Forum and the summaries of the discussion sessions.

Also on the website are the APC Contents pages and links to the President's Reports as well as workshop articles. We plan to link to selected articles from each issue in the near future.

We frequently need to update the Internet Resources Directory, and your input here would be welcome. Tell us of dead links you find, good websites that should be there, and ones that shouldn't. Keep us up-to-date! Email additions to anpc@anpc.asn.au.

From the Editor: taxonomy and plant conservation in this issue of APC

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A number of papers in this issue of *Australasian Plant Conservation* discuss the connection between taxonomy and plant conservation. Orchids are one of the most diverse plant groups in Australia, and unfortunately many are rare and threatened. **Zoe Smith, Elizabeth James** and **Cassandra McLean** bring molecular evidence to bear on the question of species boundaries in *Diuris*. They show that the highly endangered *Diuris fragrantissima* is indeed a separate species, but that populations of *Diuris punctata* currently recognised as a separate species (*D. daltontii*) are not sufficiently distinct to warrant formal recognition, but rather are local variants. Also examining orchids, **Colin Bower** asks the question 'what is an orchid species?' and provides an answer from the point of view of pollinators. Some orchids mimic the appearance and odour of female wasps to deceive males of the same species into visiting their flowers. Each orchid species seems to be pollinated by a different insect species. From the perspective of the pollinators, morphological taxonomy appears to have underestimated diversity in *Chiloglottis*, where there are as many as nine as yet undescribed species, each with its own specific pollinator. However, in *Caladenia*, the number of species is likely to have been overestimated, because there are pairs or groups of species that are morphologically very close and have the same pollinator.

Geoff Carr discusses the current state of taxonomy on the genus *Dianella* (flax-lilies), in which he suggests that there may be 5-10 times as many species as currently accepted. Carr argues that characters important for distinguishing species (such as the colour, shape and fragrance of flowers) may not be evident on herbarium specimens. In Victoria, for example, about half the species of *Dianella* recognised by Carr are rare or threatened, and many of these taxa have been previously overlooked from a conservation standpoint. **Stephen Bell, Travis Peake** and **Colin Driscoll** consider that dealing with taxonomic uncertainty is vital for appropriate conservation of populations of Weeping Myall *Acacia pendula* in the Hunter catchment, New South Wales. They discuss the uncertainty around the taxonomic status of non-pendulous forms of Weeping Myall in the Hunter region, and the possibility that stands have arisen from hybridisation or are cultivated in origin.

Taxonomy underpins ecological studies, particularly because it allows for reliable identification of species. **Brendan Lepschi** and **Bob Godfree**, working on the dynamics of invasive species in southeast Australian grasslands, argue that accurate identification in taxonomically difficult (but ecologically important) groups such as *Poa* is vital for understanding the functioning of the communities they dominate. Correct identification of exotic species is also important for collating accurate and defensible information on their occurrence, ecological function and relative importance.

Included in this issue is a piece reprinted from *Plant Talk* by **Mark Mattson** in which he critiques the notion that describing species will automatically contribute to conservation. He suggests that, rather than focusing on the number of undescribed species, it might be better for taxonomists to emphasise their potential role in providing detailed natural history information about species, since for many species it is only taxonomists who have any detailed knowledge of where and how they grow.

Standardisation of names used for plants is important in enabling everyone who uses the names (taxonomists, ecologists, horticulturalists, regenerators, park managers, etc.) to speak the same language. **Anna Monro**, **Brendan Lepschi** and **Murray Fagg** provide an introduction to the Australian Plant Census which is an ambitious project to produce an agreed list of scientific names for all native and naturalised vascular plants occurring in Australia. Already, all plants listed under the *Environment Protection and Biodiversity Conservation Act 1999* are covered, as are species from some large and iconic groups such as the Proteaceae, Chenopodiaceae and Mimosaceae.

Morphology and molecules confirm the taxonomic status of *Diuris fragrantissima*, a threatened terrestrial orchid

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Introduction

Diuris fragrantissima (Sunshine Diuris) is a perennial, terrestrial orchid endemic to Victoria. Once abundant on the Basalt Plains Grassland west of Melbourne, the species has suffered a severe population decline since the 1930s, largely attributable to habitat destruction for agricultural and urban development. It now exists as a single remnant population of approximately 25 plants and also as *ex situ* collections containing some hundreds of plants. Sunshine Diuris is listed as Critically Endangered in Victoria under the criteria of the International Union for the Conservation of Nature and Natural Resources (IUCN). A recovery plan developed by the Victorian Department of Sustainability and the Environment (DSE) includes reintroduction as an important conservation strategy.

The genus *Diuris* as a whole is easily recognised by the distinctive stalked, rounded petals projecting like donkey ears at the top of the flower and the pair of long, slender lateral sepals projecting below (Backhouse and Jeanes 1995). However, morphological variation between and within species and even within populations is extensive and has caused difficulty in defining taxa at the rank of species and below (Jones and Clements 2001).

Diuris fragrantissima was initially misidentified as *D. alba* (which does not occur in Victoria) but subsequently recognised as a white variety of the Purple Diuris, *D. punctata* var. *albo-violacea*. Clements (1989) elevated the taxon to species level, using the epithet *fragrantissima* (which is allowable because priority of epithets only exists within particular ranks, such as varieties or species). While it is clear that *D. fragrantissima* belongs within the *Diuris punctata* morphological group, its taxonomic rank within the group remains questionable. The *Diuris punctata* group includes the species *Diuris alba, D. arenaria, D. tricolor, D. oporina, D. parvipetala, D. punctata, D. dendrobioides, D. daltonii* and *D. fragrantissima*, all of which have white to purple flowers, rather than yellow to red-brown as in other morphological groups within the genus. The latter four species occur within Victoria and were the focus of the study.

Morphologically, *D. fragrantissima* is highly variable and broadly distinguished from other purple-flowered *Diuris* species by its shorter stature and generally pale-coloured, fragrantly scented flowers (Backhouse and Jeanes 1995). Its recent elevation to species (Clements 1989) when fewer than 100 plants existed, coupled with the fact that the distinguishing characters of *D. fragrantissima* are not confined to that species, warrants additional assessment of the taxon prior to the reintroduction of individuals under the conservation strategy for the species.

The combination of morphological and molecular data and information on genetic diversity provides a new opportunity to reassess existing classifications and thereby the true conservation status and requirement for reintroduction. Investigations into the phylogenetic relationships of the mycorrhizal fungi associated with species of the *D. punctata* group have also been conducted but are not discussed here.

Here we give a brief overview of a study combining data from DNA sequencing, genetic diversity and morphological comparisons on the taxonomic placement of *D. fragrantissima* and an evaluation of the usefulness of combined morphology, sequence and Amplified Fragment Length Polymorphism (AFLP) data in delimitation of closely related *Diuris* species (Smith 2006).

Direct sequencing of nuclear and chloroplast DNA

The taxonomic placement of *D. fragrantissima* within the Victorian *Diuris punctata* species group was initially investigated by sequencing two regions of DNA, nuclear ITS (internal transcribed spacer) and chloroplast *trn*T-F (Smith *et al.* 2005). These DNA regions have been used to define phylogenetic relationships at various taxonomic levels within Orchidaceae. Sequencing showed genetic distinction between yellow and purple flowered *Diuris* species, which formed separate, statistically well-supported groups. However, DNA sequence data provided little insight into relationships among the closely related taxa in the purple-flowered *D. punctata* group.

Amplified Fragment Length Polymorphism (AFLP) analysis

AFLP is a genetic fingerprinting method commonly used for population genetic studies, but can be useful for inferring relationships among closely related orchid

species, particularly where direct sequencing of nuclear and chloroplast DNA regions have provided little or no resolution. AFLP analysis resolved relationships within the Victorian members of the *D. punctata* group, confirming the recognition of *D. fragrantissima* at species rank, and provided information on levels of genetic variation and gene flow among populations and species (Smith *et al.* 2007). AFLP data across different individuals can be summarised as a dendrogram (Fig. 1) in which individuals that are most similar on the basis of the genetic fingerprints cluster together. All individuals of *D. fragrantissima* (both *in situ* and *ex situ*) formed a separate cluster to the cluster containing all individuals from four populations of *D. punctata*. A group of individuals from The Grampians identified as *D. daltonii* fell within the *D. punctata* cluster. Samples of *D. dendrobioides* fell into two distinct clusters, one each for the Boorhaman and Bonegilla populations.

Morphological investigation

The morphological component assessed which characters were able to determine species boundaries/limits under the current taxonomy of the *D. punctata* species complex in Victoria. Eighty characters, including floral and vegetative characters, were measured *in situ*. The importance of flower colour in distinguishing taxa was highlighted. However, floral fragrance, one of the few characters currently used to distinguish *D. fragrantissima* from its close relatives, was found to be uninformative because all *Diuris* species sampled in this study produced fragrant flowers. Figure 2 shows some of the floral morphology recorded.

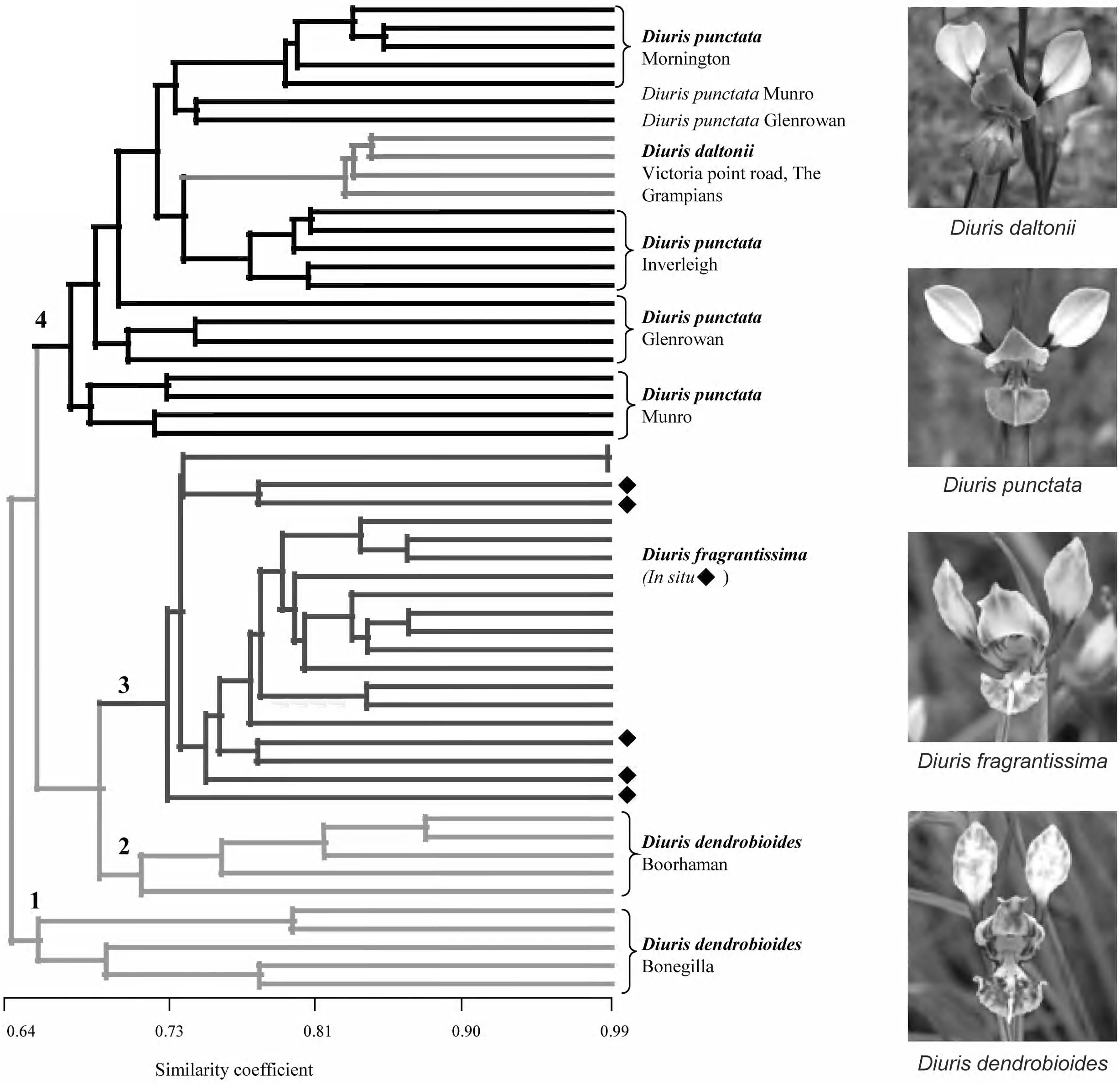

Figure 1. Dendrogram produced from AFLP data showing similarity of individuals based on number of shared bands in the genetic fingerprint. The similarity coefficient indicates the level of similarity between individuals. In the dendrogram, individuals that are most similar are grouped together. Four clusters of individuals are marked: 1: Diuris dendrobioides *from Bonegilla, 2:* Diuris dendrobioides *from Boorhaman, 3:* D. fragrantissima *(all individuals, both* in situ *and* ex situ*), and 4:* D. punctata*, including a cluster containing individuals from The Grampians assigned to* D. daltonii*. Photos: Zoe Smith*

Implications for orchid conservation and reintroduction

This study has shown that *D. fragrantissima* is a separate taxon, both genetically and morphologically, from other Victorian species in the *D. punctata* group, justifying its recognition as a unique entity for conservation. Clustering of *D. daltonii* within *D. punctata,* in the AFLP study suggests that the recent elevation of this variety to species level in 2004 warrants further investigation. Further research into the delimitation of *D. dendrobioides* is also suggested, given the two separate clusters for this species in the AFLP analysis. It is recommended from our studies that future classifications of Australian terrestrial orchids must incorporate sufficient sampling to account for extensive intra-population variation. Otherwise, taxa such as *D. daltonii,* in this study found to cluster within *D. punctata,* will be elevated unnecessarily to species level and therefore receive unwarranted higher conservation priority.

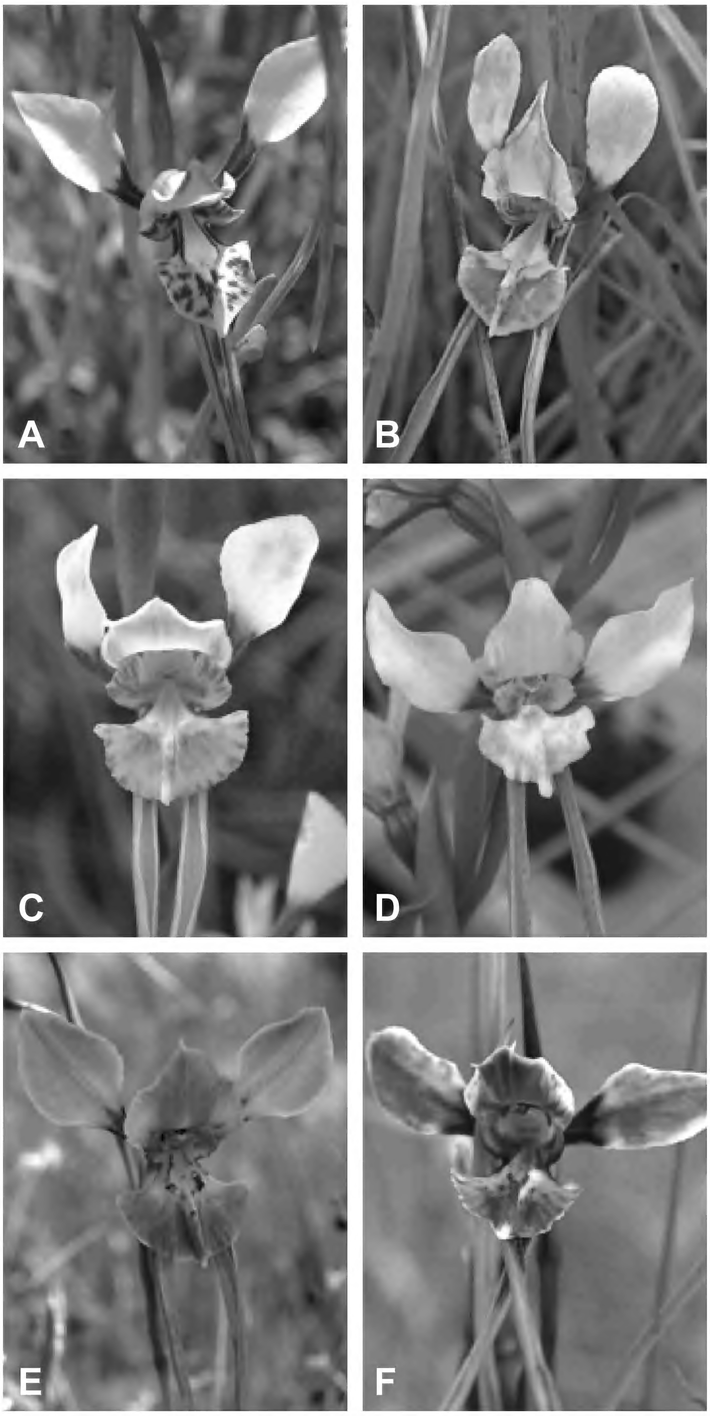

Figure 2. Examples of variations within the Diuris punctata *group. A-B:* Diuris dendrobioides*. C-D:* D. fragrantissima*. E-F:* D. punctata*. Petal colour intensity ranges from white (A-B) to purple (F) and edge shape either smooth (A, D) or wavy (B). Callus white to cream (A-D) or golden yellow (E-F). Lateral sepals (the long 'tails' projecting below) range in colour from green (B-D) to purple (E-F). Photos: Zoe Smith*

One of the main goals of the conservation program for *D. fragrantissima* is to maximise the genetic variability remaining so that the evolutionary potential of the species is not lost inadvertently. We found a comparable level of genetic diversity between *in situ* and *ex situ D. fragrantissima* and its more common relatives (Smith *et al.* 2007) indicating the high conservation value of the *ex situ* collection as source material for reintroduction.

The close relationships between species studied here may assist in making decisions regarding suitable reintroduction sites, mycorrhizae and pollinator relationships, which are all important considerations for developing self-sustaining populations. It is heartening that, despite many years of *ex situ* cultivation, *D. fragrantissima* may contain sufficient genetic diversity to maintain the potential to adapt to long-term environmental change, a requirement for the long-term persistence of reintroduced populations.

Acknowledgements

The authors sincerely thank the *Diuris fragrantissima* Recovery Team, all volunteers involved in the project and the Australian Orchid Foundation, Hansjorg Eichler Scientific Research Fund and Australian Biological Resources Study for providing funding assistance.

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What is an orchid species? Ask the pollinators!

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Introduction

Differences in pollinators have been cited as part of the evidence supporting the creation of the many new taxa described in Australian sexually deceptive (SD) orchid genera in the last 20 years or so (e.g. Carr 1991, Jones 1991, Hopper and Brown 2001). Yet the published evidence rests on pollinator collections from rather few of the large number of taxa recently described. Therefore, it is pertinent to ask 'How well do the species recognised by pollinators correlate with those differentiated by humans?' This question is being addressed in ongoing studies by the author. The general findings for two SD orchid groups, the Bird, Wasp and Ant Orchids of the *Chiloglottis* alliance and the Spider Orchids, *Caladenia* subgenus *Calonema* (=*Arachnorchis*), are summarised in this article.

Sexual deception

The sexually deceptive pollination syndrome is so named because the orchids mimic the shape, colour and odour of a sexually receptive female hymenopteran insect to deceive males into visiting them. The key feature of Australian SD orchids is that each species has a unique pollinator species (Stoutamire 1983, Bower 1996, 2006). Pollinator specificity in the *Chiloglottis* alliance and Spider Orchids is thought to be based on the orchid's mimicry of the individual sex pheromone odour emitted by females of a particular wasp species to 'call' males of the same species from a distance. This hypothesis has been verified for two *Chiloglottis* alliance species so far. Male wasps detecting the sex pheromone or the mimic follow the odour trail upwind to the female or flower. The compound produced by the orchid that mimics the sex pheremone of the wasp is called an allomone. Pollination occurs when the male's upper thorax contacts the orchid column during attempts to mate with the labellum, which to a greater or lesser degree mimics the colour and shape of a calling female. The pollinators are thynnine wasps in the family Thynninae, also known as Flower Wasps.

Orchid species recognition using specific pollinators

Pollinators are potentially a powerful tool for species recognition in SD orchids owing to the specific orchid-pollinator relationships (Bower 1996, 2006). Two SD orchid populations that always attract different pollinators are considered to be different species since there can be no exchange of genetic material between them. The pollinator difference isolates them genetically from each other, even though they may be growing side by side in the field, or are very similar morphologically. Lack of interbreeding has long been considered to define the boundary between two species. Species with barriers to genetic exchange are known as 'biological species' or 'biospecies' by contrast with 'morphological species' or 'morphospecies', that are defined primarily on the basis of structural differences.

Demonstrating pollinator specificity

Controlled choice trials in the field are useful for determining whether orchid flowers from different colonies or populations attract the same pollinators and hence are likely to have identical allomones (Bower 1996). Essentially, samples of orchids in vials of water, mounted in blocks or racks, are placed on the ground in a line perpendicular to the prevailing wind. The orchid allomones are carried downwind and attracted pollinators follow their individual odour upwind to the orchid sample, thereby 'choosing' among the samples. Controls guard against false negatives, which may occur when pollinators fail to respond to a sample with their allomone because another sample of the same orchid species is more attractive, perhaps with fresher flowers, for example.

Wasps are captured by lowering an insect net over the flowers to which they are attracted. Observations of behaviour ensure they are capable of effecting pollination, thereby confirming them as pollinators (Bower 1996). Captured wasps are identified by the relevant authority (Dr. Graham Brown in Darwin for thynnines).

The *Chiloglottis* alliance

The Wasp, Ant and Bird Orchids of the *Chiloglottis* alliance are confined to eastern Australia and comprise 24 described species. Some of these were identified with the help of specific pollinators, including *C. platyptera*, *C. pluricallata*, *C. seminuda* and *C. valida* (Jones 1991).

Pollinators have been collected, and their specificity determined, for 18 of the described species (Bower 1996, 2006, unpublished data). In all cases, each orchid has a single pollinator that is not attracted to any other *Chiloglottis* alliance species within the same geographical region, although the relationship may occasionally break down at the boundaries of geographical regions. The data confirm that coexisting morphospecies in the *Chiloglottis* alliance have different specific pollinators, and therefore are also distinct biospecies. However, a surprising result has been the detection of nine

previously unidentified cryptic species by their specific pollinators. Some of these are indistinguishable morphologically from sister species with which they coexist, and others have subtle, but consistent character differences. The detection of two cryptic sister species of *Chiloglottis valida* in southern NSW and Victoria by pollinator specificity is discussed in Bower (2006).

Figure 1. Caladenia australis, C. calcicola *and* C. reticulata*; all pollinated by the same thynnine wasp species,* Phymatothynnus *near* nitidus*. Photos: Colin Bower*

Spider Orchids, *Caladenia* subgenus *Calonema*

The Spider Orchids, *Caladenia* subgenus *Calonema*, include many of the most spectacular terrestrial orchids in southern Australia. The subgenus has radiated extensively in south eastern and south western Australia, and currently comprises about 170 described species, many of which are highly localised and rare. Some 48 species are listed as threatened under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999.*

Evidence of a different pollinator has been specifically cited in the description of only one *Caladenia* species, *C. phaeoclavia*, by Jones (1991). In general, current pollinator studies on the Spider Orchids are showing less agreement than for the *Chiloglottis* alliance between biospecies recognised by wasps and the morphospecies defined by taxonomists. So far, three groups of morphospecies within *Caladenia* have been found to share the same pollinator, indicating they belong to the same biospecies;

- *Caladenia concinna* and *C. toxochila* both attract *Aeolothynnus generosus*.
- *C. reticulata*, *C. calcicola* and *C. australis* are all pollinated by *Phymatothynnus* near *nitidus* (Fig. 1).
- *C. parva*, *C. phaeoclavia* and *C. villosissima* are all pollinated by *Lophocheilus anilitatus* (Fig. 2).

In contrast, there are two examples of undescribed cryptic pollinator-specific *Caladenia* species in inland NSW, one each in *C. tentaculata* and *C. concinna* (Fig. 3).

Figure 2. Caladenia phaeoclavia *and* C. villosissima*; both pollinated by* Lophocheilus anilitatus*. Photos: Colin Bower*

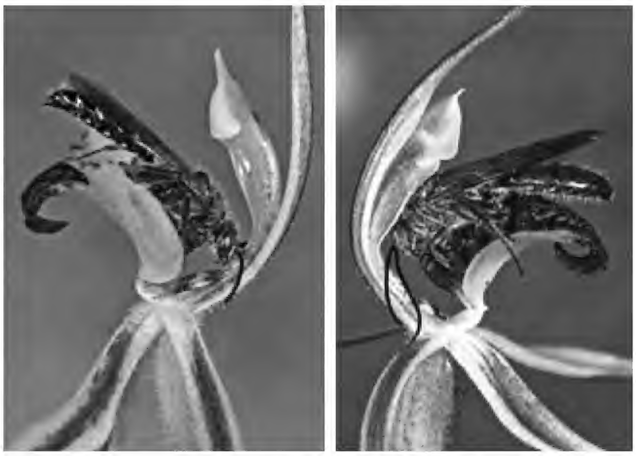

Figure 3. Caladenia concinna*, pollinated by* Aeolothynnus generosus*, and its cryptic sister species,* C. *aff.* concinna*, pollinated by* Neozeleboria *near* polita*. Photos: Colin Bower*

Implications for threatened species

The data indicate that taxonomists have underestimated diversity in *Chiloglottis* and overestimated it in *Caladenia*. In *Caladenia*, taxonomists appear to have given more weight to small morphological differences, supposed habitat differences and geographical separation than may be warranted.

What does this mean for threatened species? For *Chiloglottis*, some of the undescribed cryptic species are likely to meet criteria for threatened status, but lack distinguishing morphological features for formal circumscription as species, except for the pollinator difference. This poses potential problems for identifying and conserving these taxa in the field.

In *Caladenia*, one species regarded as Vulnerable, *C. calcicola*, is the same biologically as other more common sister taxa (*C. reticulata* and *C. australis*), so that its status as threatened is questionable. Uncertainty regarding the taxonomic status of threatened species may present decision makers with difficulties for allocation of scarce resources.

Conclusion

So what is an orchid species? For sexually deceptive orchids, it depends on whether you are human or hymenopteran. Ideally, the two views should be aligned.

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Taxonomy of *Dianella* and implications for conservation

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Introduction

The genus *Dianella* (Hemerocallidaceae) (flax-lilies) is currently understood to contain 30-40 species. The genus occurs in Zimbabwe, Madagascar, Mauritius, India, Sri Lanka, Vietnam, Laos, Thailand, Myanmar, Taiwan, Japan, Korea, Malesia, Australia, New Zealand, New Caledonia, and numerous Western, Central and South Pacific islands, east to Hawaii and Pitcairn Islands. Most species, and maximum infrageneric diversity, occur in Australia, clearly the centre of distribution. *Dianella* occupies a wide range of habitats from equatorial rainforests to southern Tasmania. Radiation apparently occurred from tropical/subtropical precursors into diverse temperate environments, including arid Australia, in the Tertiary and Quaternary.

The fleshy fruits of *Dianella* are bird-dispersed. The genus is inferred to have dispersed from Australia (and probably New Guinea, New Caledonia and New Zealand) to Asia, Africa, and across the Pacific Ocean. Its dispersal capacity is seen in Hawaii (with three endemic species) which is 2500 km from the nearest *Dianella* occurrence.

Dianella has suffered extreme neglect at the hands of taxonomists, which has obfuscated the remarkable diversity within the genus, and rendered invisible the conservation plight of numerous, mostly undescribed, species.

Taxonomic history of *Dianella*

Approximately 100 *Dianella* names have been published – mostly as species, though many were described at infra-specific rank and require elevation to specific rank. There are also numerous names (e.g. Henderson 1987) published for Australian and extra-Australian taxa that are invalid, illegitimate, superfluous or of uncertain application (due to inadequate circumscription, loss of types, and inadequate types). *Dianella* was described in 1789, the original species (type) being *D. ensifolia* from India (Henderson 1987). The only global monographic treatment was by Schlittler (1940). Schlittler (1948) separately treated Malesian *Dianella* (Indonesia, Singapore, Malaysia, Indonesia, Philippines, New Guinea and Solomon Islands) recognising 17 *formae* of *D. ensifolia*. Jessop (1979) reduced all 17 taxa (Schlittler's *formae*) to synonyms of *D. ensifolia* (many are in fact distantly related to *D. ensifolia*).

Henderson's (1987) *Flora of Australia* account is the most recent treatment for the Australia species of *Dianella*; 15 species and 20 varieties are recognised (many described as new) and some 10 names are relegated to synonymy. In Australia since then, five new species have been published and two elevated to specific rank (e.g. Carr & Horsfall 1995, Carr 2006a). Far from being a small genus, *Dianella* contains at least 350 species, as revealed by our studies (Carr & Horsfall unpubl. data) spanning more than 20 years; we have detected multiple new species based on extensive field and herbarium studies in Australia, Indonesia and Malaysia.

It seems strange that such divergence of opinion can arise between taxonomists. Opinions vary, for example between eucalyptologists or orchidologists, on the authenticity or rank of taxa, but the extent of divergence of opinion here appears unprecedented.

Left: Dianella *sp. (Licola) is known from a single plant in riparian forest at Licola, Victoria. Right:* Dianella *sp. aff.* amoena *(Barrington Tops), a rare species of Snow Gum woodland on the NSW Northern Tablelands. Photos: G.W. Carr*

Divergence of taxonomic opinion

During our extensive botanical surveys, it soon became evident that species we found did not match the circumscription of taxa allegedly present, or that several different entities laboured under one name. On what basis do we discriminate between taxa?

There is a very large array of macroscopic and anatomical, vegetative and fertile, chemical, cytological, ecological and phenological characters available to discriminate taxa. Each of the approximately 250 undescribed entities we recognise poses a unique suite of discontinuous character states. Most features are lost or obscured in herbarium collections: material is often poorly collected and curated, and usually unaccompanied by data (e.g. habit, habitat, colour) which may otherwise allow interpretation of specimens. *Dianella* is unusual in having evanescent flowers. Except for the four species in the *D. tasmanica* group (three undescribed), flowers open and finish on day one; they often last only 4-6 hours, then the perianth cells lyse and liquify. In most herbarium collections floral details are lost (e.g. colour, shape, relative proportions, floral fragrance). We place great weight on these floral features, and also on habit and other vegetative features.

Many taxonomists who describe new *Dianella* have field knowledge of live plants (e.g. Carr & Horsfall 1995, Heenan & de Lange 2007) whereas herbarium-based taxonomic 'lumpers' are mostly unfamiliar with live plants, and often worked in the opposite hemisphere with dead and poorly-pressed and curated material (e.g. Schlittler 1940, 1948; Jessop 1979; Henderson 1987).

A corollary of taxonomic 'lumping' at the broad geographic scale (Schlittler 1940, Henderson 1987, Jessop 1979) is seen in subsequent regional or state flora treatments. These wider taxonomic treatments have set the 'taxonomic climate', the prism through which the genus is viewed; subsequent treatments become reiterations. This narrowing of vision is seen in Australian flora treatments subsequent to Henderson's (1987) revision, such as in *Flora of Victoria* (1994) and *The Western Australian Flora* (2000). Table 1 indicates the number of taxa recognised in Victorian flora treatments since the mid nineteenth century.

An extra-Australian example is seen in the floristic inventory of Mt Kinabalu, Borneo. The inventory of the Mt Kinabalu *Dianella* (and also *Rhuacophila*) flora (Carr 2006b) illustrates a similar trend. Following Jessop (1979), Beaman and Anderson (2004) recognised two *Dianella* species, (one a *Rhuacophila* incorrectly subsumed in *Dianella*). I found that neither species of *Dianella* (or *Rhuacophila*) allegedly present occurs at Mt Kinabalu, rather, it has five *Dianella* (some undescribed endemics) and two *Rhuacophila* spp. (one undescribed presumed endemic) (Carr 2006b).

Table 1. Dianella *recognised in flora treatments for Victoria*

Treatment	Number of taxa recognised for Victoria
Mueller (*Fragmenta phytographiæ Australiæ* 1867-1868)	5 species
Bentham (*Flora Australiensis* 1878)	5 species
Ewart (*Flora of Victoria* 1931)	3 species, 1 variety
Willis (*A Handbook to Plants in Victoria* 1970)	4 species
Conran (*Flora of Victoria* 1994)	4 species, 5 varieties
Conran (1994) plus Carr and Horsfall (1995)	9 species, 2 varieties
Carr (Checklist of Victorian *Dianella* ms. 2007)	33 taxa, 24 undescribed species, a few undescribed subspecies or varieties.

Taxonomy and conservation

Taxonomy underpins all biological disciplines, not least conservation management of threatened species. Of the 33 Victorian *Dianella* taxa which I accept, 17 have a conservation status: they are data deficient, rare, vulnerable, endangered or critically endangered. Remarkably,

seven are known from five plants or fewer in the field. Many threatened taxa have become rare because they occur in grasslands or woodlands on fertile soils long-cleared for agriculture. Now that clearing of indigenous vegetation has largely ceased, the major threat is environmental weed invasion.

It is important to describe new taxa as soon as possible, although undescribed taxa may be listed under state and federal conservation legislation. Formal description usually presents data, often otherwise unavailable, on relationships, biology, ecology, distribution, threats, etc. Formal description also alerts to taxonomically isolated species which may be given higher conservation management priority, such as *Dianella tenuissima* (Carr 2006b).

Formal description also alerts the botanical community to taxa requiring investigation to determine distribution, biology, ecology and conservation status, hence management requirements. This is exemplified by *D. amoena* (Carr & Horsfall 1995) overlooked for about 130 years (the rare collections were shoe-horned into other species). It has now been listed as nationally vulnerable under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*. Multiple populations have been found, but almost none reserved.

From an academic viewpoint, the delimitation of *Dianella* globally - describing all taxa and elucidating infra-generic relationships - is part of the ripping yarn of biodiversity evolution. *Dianella* has an unusual distribution and biogeographic history. Among petaloid monocotyledons (in the families Lilianae, Alismatanae and Commelinanae) *Dianella* will ultimately prove to be one of the largest of genera, excluding Orchidaceae. With about 350 species the genus currently ranks about sixth in size, ahead of *Smilax* (Smilacaceae - 300 spp.) and behind *Aloe* (Asphodelaceae - 400 spp.), and *Calamus* (Arecaceae - 400 spp.). It may go much higher because systematic field work has been conducted in only a fraction of its distribution; by far the greatest species richness occurs in New South Wales and Queensland. Funding is urgently required for taxonomic work to proceed.

Top: Dianella *sp. aff.* tasmanica *(Snowy River), a rare species of eastern Victoria; its ripe fruits, shown here, are green.*
Bottom: Dianella *sp. aff.* caerulea *(Georges River), an endangered species known from one tiny population in Sydney, NSW.*
Photos: G.W. Carr

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Dealing with taxonomic uncertainty in Weeping Myall *Acacia pendula* from the Hunter catchment, New South Wales

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Weeping Myall (*Acacia pendula*) is a widespread wattle within Australia, occurring in New South Wales, Victoria, South Australia and Queensland. Populations of Weeping Myall in the Hunter Valley catchment of NSW are listed as endangered on the NSW *Threatened Species Conservation Act 1995*. This species also forms a prominent component of listed vegetation communities: both the State listed *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion* Endangered Ecological Community (EEC) and the Commonwealth's *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley* Critically Endangered Ecological Community (CEEC). Both Commonwealth and State determinations note the Jerry's Plains cemetery as the main area of occurrence of Weeping Myall in the Hunter. The Department of Environment and Climate Change (NSW) is in the preliminary stages of preparing a recovery plan for the Hunter Valley population. However, recent investigations have shown some ambiguities in the morphology of this species in the Hunter, with possible taxonomic (and hence conservation) implications.

Taxonomic problems

Positive identification of Weeping Myall within the Hunter has historically been difficult due to the lack of flowering and fruiting material, critical in distinguishing this species from its close relatives *Acacia melvillei* and *A. homalophylla* (Yarran). Weeping Myall possesses winged pods, a feature which is absent in the other two species, and seeds are transverse in the pod, which is shared only with *A. melvillei*. Without these features, it is difficult to differentiate the three species with confidence. Added to this is the non-pendulous nature of juvenile Weeping Myall specimens, until a height of around two metres whereupon the pendulous habit becomes obvious.

Recent reviews of Weeping Myall within the Hunter Catchment have recognised two forms of the species (Umwelt 2006a; Bell 2007). The first of these can be considered typical of the taxon, with gracefully pendulous grey-green foliage on single-stemmed individuals (Fig. 1). This form is very rare in the Hunter, and is represented

Left: Figure 1. Acacia pendula *(planted pendulous form) at Sandy Hollow, upper Hunter Valley.*
Right: Figure 2. Acacia pendula *(non-pendulous suckering form) on private land near Singleton*

almost exclusively by plantings of the species from Newcastle on the coast, to Cassilis in the far west of the catchment. The second form (Fig. 2) is considerably more widespread, and is typified by a non-pendulous habit and vigorous root suckering. It occurs west from Broke and is particularly prevalent in the Singleton-Muswellbrook areas. On general impressions, the two forms are markedly different, however the paucity of fertile material makes identification very difficult.

Monitoring of both forms of the Hunter Valley specimens has been on-going since early 2006, and some preliminary morphological data have been collected with a view to establishing the status of each form. While flowering and fruiting has been prolific in the planted pendulous form, the non-pendulous form rarely flowers. Disappointingly, recent flowering of some non-pendulous specimens in early 2007 did not progress to fruit production, despite their pendulous counterparts doing so.

On-ground recognition

Although Weeping Myall in its typical form is unmistakable in the western parts of its range, the tendency to form non-pendulous clumps and its very poor flowering in the Hunter Valley makes on-ground recognition of this species difficult. At present, both pendulous and non-pendulous forms are included within conservation planning frameworks in the Hunter, until such time that further clarification on taxonomy can be attained. Interestingly, the majority of known stands of the non-pendulous form occur as mono-specific stands in agricultural landscapes, and few occur in remnant native mixed species stands of woodland or forest. This fact in itself raises an intriguing question: were these non-pendulous forms planted as stock fodder many decades previously, perhaps mistakenly thought of as Mulga (*Acacia aneura*)? The vigorous clonal nature of the Hunter plants is also characteristic of the non-pendulous forms (Fig. 3), but is rarely reported for pendulous forms.

Stands of *Acacia* at Jerry's Plains cemetery (the site listed in both NSW and Commonwealth legislation) include both non-pendulous and pendulous forms, but neither has flowered and progressed to fruiting in recent years. The main stand of the pendulous form also occupies a clearly rectangular pattern, which is at odds with other stands of co-occurring trees *Acacia salicina* and *Geijera parviflora* that are widespread in the Jerry's Plains area. In addition, examination of aerial photographs from 1954, 1958, 1982 and 1996 shows that the entire cemetery site was devoid of almost all woody vegetation between 1954 and 1958 (Umwelt 2006b), indicating that all present-day woody vegetation is secondary regrowth. Small stands of what was likely to have been *Acacia pendula* were present in the 1954 photograph, prior to the clearing.

The way forward

Central to progressing with the recovery planning process are some simple yet important questions. Are there any naturally occurring pendulous forms of *Acacia pendula* present within the Hunter? Could the widespread non-pendulous forms be sterile hybrids, and if so how can their identity be resolved? Despite inclusion in both State and Commonwealth legislation, is it possible that the Jerry's Plains specimens are not native to the area and have also been planted? Why do virtually all known specimens of *Acacia pendula* in the Hunter catchment occur as mono-specific stands within agricultural lands, rather than within remnant woodlands or forests? These simple questions may have important implications for the protection of *Acacia pendula* in the Hunter catchment, not the least of which relate to recovery planning for the species. Elsewhere in its range, *Acacia pendula* appears to be a resilient species capable of surviving under intense clearing pressures: one of the authors (CD) recently drove through about 300 km of *Acacia pendula* at the northern limit of its range between Charleville and Roma in Queensland, and all plants were distinctly pendulous with none having the erect form that is seen in the Hunter Valley. It was also obvious that these plants were native to the local area through their regular occurrence across the fragmented grazing landscape, and responded to past clearing through dense regrowth. From this perspective, is it possible that the same taxon could be almost completely wiped out in the Hunter Valley? Perhaps detailed DNA and morphological studies will be the only way to resolve this issue for the Acacias in the Hunter catchment.

Figure 3. Acacia pendula *(non-pendulous suckering form) on private land near Singleton*

Acknowledgements

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Dynamics of plant invasions in southeast Australian grasslands: trust your taxonomists

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Invasive species are a major problem for conservation of native vegetation both in Australia and globally. Invaders frequently dominate native plant communities, changing their structure, floristic composition and conservation value. Over the past five years, we have been researching grassland community structure and function and the dynamics of invasions within these communities, with a focus on southeastern Australia. Sound taxonomy, particularly in identification of grasses, has been an important underpinning of this research.

Invasion in subalpine communities

An initial study on the subalpine plant communities of Long Plain in Kosciuszko National Park (Godfree *et al.* 2004), yielded important data on both community invasibility, and the comparative invasive ability of different exotic species. Our research indicated varying degrees of invasibility for the four communities present in the study area (*Eucalyptus pauciflora* forest, *Eucalyptus pauciflora – E. stellulata* woodland, *Poa* grassland and *Carex – Poa* bog), with grasslands and woodlands the most susceptible to invasion. Ecotonal communities at the grassland-woodland boundary contained especially diverse exotic assemblages. Few exotic species were able to penetrate *Eucalyptus pauciflora* forest, and those that did were present in very low numbers, and no exotic species were recorded from *Carex – Poa* bog communities. We also found that the most diverse native plant communities also tended to have more exotic species, which contrasts with the 'diversity-resistance hypothesis' of invasions which predicts that diverse communities are highly competitive and readily resist invasion (Elton 1958).

Strong evidence was also obtained of ecological filtering, in that, of the total pool of exotics present in disturbed environments in the Long Plain area, only a fraction of these taxa are able to successfully invade intact vegetation communities. Those that do, such as *Acetosella vulgaris, Hypochaeris radicata* and *Trifolium repens*, are characterised by particular life-history traits (e.g. perenniality and vegetative growth) that are consistently selected for by the filtering process.

Overall, many successful invasive species are functionally similar to native species in the community, and occupy similar positions in the community dominance hierarchy. Functionally similar native 'analogues' are also present for nearly all invasive species (e.g. *Brachyscome scapigera* and *Podolepis robusta* for *H. radicata*) indicating a tendency for functional convergence between native species and invaders. The only exception is that there is no native analogue for *T. repens*. The presence of functionally analogous invaders is in contrast to many other studies (see Godfree *et al.* 2004), which indicate that successful community invaders usually represent novel functional groups or lifeforms (for example *Opuntia* spp. in eucalypt woodlands in eastern Australia; see also below). The differing results obtained in our study suggest that external environmental factors (such as the more extreme climatic conditions of the subalpine) also play a part in determining the success of invasions and the resilience of communities to invasion.

Invasion in grassland communities

Following on from the work at Long Plain, we have expanded our research to further examine the ecological function, structure and small-scale dynamics of grassland communities in southeastern Australia. In particular, our research is focused and understanding the relationship between community diversity and invasibility. Our study area encompassess structurally similar but floristically diverse grassland communities from alpine areas (e.g. Mt Carruthers, Koscziusko NP) to the western plains (e.g. West Wyalong). Extensive surveys have been undertaken at a range of spatial scales, ranging from individual plant (0.01 m^2) to geographic (300+ km).

Data have been collated on species composition, abundance, cover, functional classes and trait characteristics, for more than 500 taxa, both native and exotic. These data are currently being analysed for publication in the near future, but preliminary evidence suggests that both large- and small-scale ecological processes drive patterns in the diversity of native and exotic species in SE Australian grassland assemblages. For example, our data show that exotic species richness generally declines with elevation while native assemblages maintain high levels of diversity even at the highest elevations (Fig. 1a). Significant transitions are also evident in the composition of exotic assemblages with increased elevation: annual species dominate at low sites while perennial species are most common at intermediate altitudes (Fig. 1b). Interestingly, native plant communities also appear more resistant to invasions by exotic species at higher elevations (Fig. 1c). In addition, our data suggest that diversity of native species tends to be positively related to invasibility at all spatial scales and that a few dominant grasses generally exclude all other subordinate species in

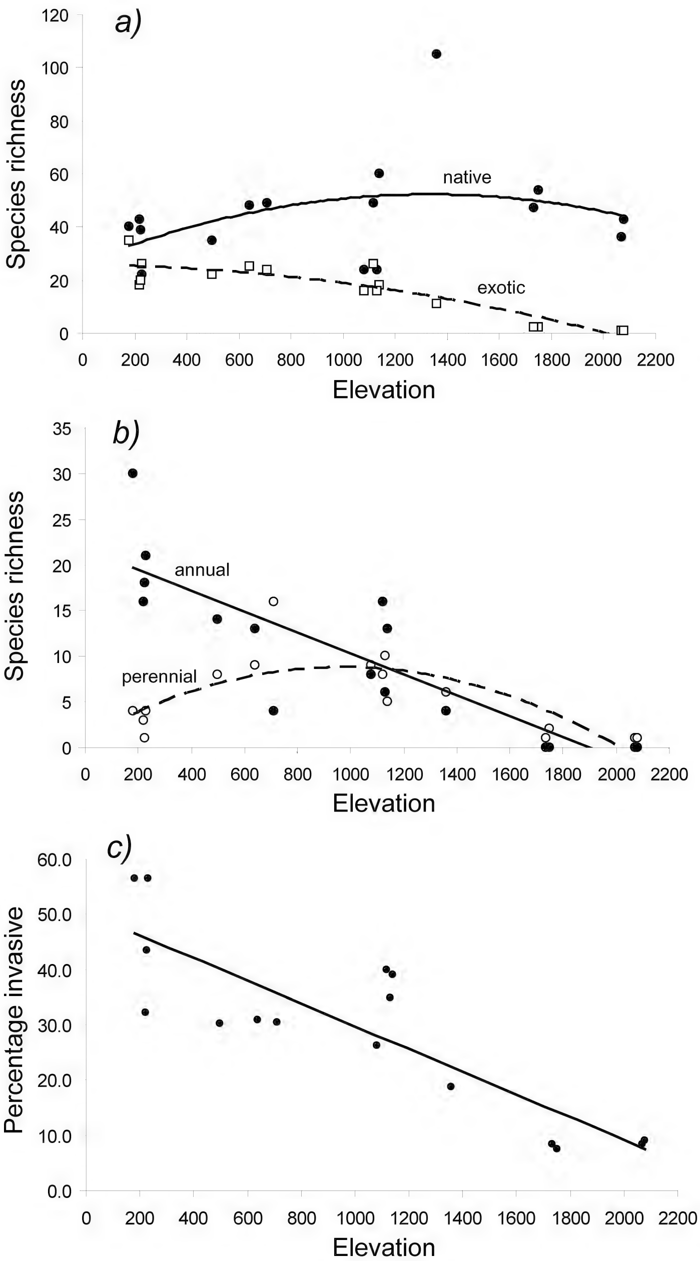

Figure 1. Relationships between elevation and floristic composition of native and exotic plant assemblages in temperate southeast Australian grasslands. a) native and exotic species richness; b) numbers of perennial and annual exotic species; c) percentage of total exotic flora at a site exhibiting the capacity to invade native plant communities.

SE Australian grassland assemblages. These results suggest that managing native grasslands for higher diversity is unlikely to be an effective strategy to minimize invasion by exotic species.

Invasion in *Austrostipa* grasslands

We are also focusing in more detail on small-scale community interactions within the *Austrostipa aristiglumis* grasslands of the West Wyalong area. These communities are of particular interest because they have been heavily invaded by functional groups (such as annual grasses and annual legumes) that are rare or absent in the native flora, a contrasting situation to that in our Long Plain study. In an ongoing three-year project we have been examining the effects of exotic species on the native grassland flora through a series of manipulation experiments involving hand-removal, grazing and other treatments, along with other research into soil nutrient levels, water availability and other related factors. A greater understanding of the factors leading to invasion of these endangered communities will lead to a better understanding of the mechanisms of invasion in regions with erratic climates, and to better management of native biodiversity. A climate change component has also recently been initiated, researching the potential effects of predicted climate change on the composition of these communities.

Taxonomy underpins ecological research

Underlying this research, from our initial work at Long Plain, through to our current work at West Wyalong, is the fundamental importance of a sound taxonomic basis from which to work. Each component of this work has relied on a detailed understanding of the taxa involved, and has resulted in countless hours of collection, identification, comparison and research. Much of this has proved relatively straightforward, but in some cases taxonomic identity has been the subject of much conjecture and disagreement among the research team! A good example is the genus *Poa*, a notoriously complex assemblage of species present in many environments in southern and eastern Australia, particularly at higher altitudes. Estimation of relative abundance and cover of a range of *Poa* taxa in various components of our research required detailed survey, sampling, collection and identification of a large volume of material. This proved invaluable, not only for our immediate research, but also for other related projects (e.g. Godfree *et al.* 2006), and has led to

A glabrous form of Poa sieberiana *that actually keys to* P. mionectes*, which it is not, based on genetic data. Photo: Anthony Davidson*

Poa labillardierei - *forms growing on dry slopes can be difficult to distinguish from* P. sieberiana*, and genetically it forms a complex with* P. sieberiana*. Photo: Anthony Davidson*

separate project examining (and ultimately supporting) the robustness of current classifications in the genus using taxonomic, molecular and ecological data (Davidson, Godfree, Broadhurst and Lepschi unpubl.). *Poa* species are of critical importance ecologically, and their accurate identification is paramount to understanding the functioning of the communities they dominate.

Similarly, correct identification of exotic species is also important, allowing us to collate accurate and defensible information on their occurrence, ecological function and relative importance. Taxa such as *Avena*, *Bromus*, *Chenopodium*, *Hypochoeris*, *Lolium*, *Medicago*, *Sonchus*, *Trifolium* and *Vulpia* have been of particular taxonomic and ecological interest. Our work has also yielded additional herbarium collections of poorly represented taxa, especially weeds, and highlighted the still significant gaps in our understanding of the taxonomy, distribution and ecology of our native and exotic flora, even in a relatively well studied region such as southeastern Australia.

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What of the ecologist within? Red lists, red herrings and the taxonomic impediment

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'The earth will be safe when we feel safe in ourselves'
(Thich Nhat Hanh)

It has become commonplace to observe that a 'taxonomic impediment' stands in the way of biodiversity conservation. The claim that taxonomy is the basis of all biology is restated with growing urgency. Current approaches to this problem frequently advocate an IT-driven, corrective, retrospective addition of taxonomic competence, like an overlooked ingredient in the stew of biological knowledge. Taxonomy cannot simply be added, however, because foundational knowledge cannot be added as an afterthought, especially if there is nothing to add it to.

We proclaim taxonomy's importance to biology. But what has become of biology itself? Thoughtful botanists lament the decline of 'whole-plant' studies, natural history, practical field botany, identification skills and basic, applied plant knowledge. Can we redeem taxonomy in the absence of botany? There is concern that academic biology (including taxonomy) has become too narrow and specialized, to the detriment of conservation efforts and society's needs. What then is the real impediment? The 'taxonomic impediment' is surely a red herring, because taxonomy itself is a casualty of the state of modern biology. Furthermore, the 'taxonomic impediment' has been related to biodiversity conservation with little thought. We seem to think that we can resurrect taxonomy to spectacular heights without reflecting on biology as a whole. Hence the growing initiative to document every living species on earth, and to develop a complete genome of all life; some organizations claim that this will represent 'one of the greatest human achievements of all time'. This narrow grandiosity is not helpful, because it deflects attention from the real challenges facing us.

Our focus on information technology, Red Lists and bio-information requires scrutiny. An information culture is

invaluable in an ever-changing world, but the internet is as useful to neo-Nazis as it is to stamp collectors. Its significance depends entirely on the consciousness of those who add content to it and who use it. A web-based inventory of all life, complete with Red-listed species, is certainly needed. But its usefulness depends on the wisdom that wields it, and it will not impose uniform ecological values on everybody. Such maturation relies on interior, cognitive development, while technology addresses only objective, exterior domains. Furthermore, without natural history and field experience, taxonomy becomes an abstraction, a free-floating collection of prescriptions for ordering taxa. Such frameworks are needed, but they do not equate to the deep knowledge of organisms from which ecological understanding grows. This knowledge is a vital aspect of taxonomic training, and it cannot be acquired from a CD-ROM.

The necessary relationship between taxonomy, natural history and ecology has been overlooked by ecologists long preoccupied with theory-bound approaches to method. When faced with the real world of poor data and complex habitat relationships, conservation biology often lacks critical autecological information. Taxonomists should emphasize their potential role in providing the case-specific natural history knowledge of taxa that we lack, and that is now being recognized as crucial for research design. Taxonomists will also benefit from asserting the wholly scientific nature of their discipline, which makes it a good vehicle for teaching scientific method and the philosophy of science, both of which are neglected essentials in the training of conservation biologists.

Promoters of taxonomy warn that many taxa will become extinct before they have been described. This is not the most skilful way to advance the discipline. The assigning of Latin binomials will not protect unnamed species while we fail to transform the human values that imperil them. In an age of bioprospecting and genetic engineering, scientific description is often linked to utility, profit and power, the same motivations which render our behaviour so destructive. If taxonomy is promoted as a vehicle for the pursuit of utilitarian reward, then on what platform will taxonomists stand to proclaim intrinsic worth, which is the foundation of a mature environmentalism? The contention that potential utility and possible extinction demand renewed taxonomic effort is true, but contributes little to the evolution of our ecological sensibilities.

Ecology requires a more reflective view of itself, because our most pressing concern is not what ecology ought to become – but rather what we must become in order to practice it. This approach recognizes that environmental problems are creations of our individual and collective behaviour, and can be traced to psychological forces, i.e. our beliefs, perceptions, insecurities and defences. The prevalence of these forces also underpins the political, economic and social injustices which significantly drive biodiversity loss. From this perspective, competence in ecology has much to do with understanding the roots of our own behaviour, and transforming it. According to the Dalai Lama, such an undertaking requires a 'balanced development of outer scientific and inner psychological capacities'.

Ecological wisdom is not needed to protect the biosphere – it is needed to bring humans into agreement on how this can be done. What prevents such consensus is a lack of human generosity, empathy and mutual understanding, and a failure to see beyond narrow self-interest. Put bluntly, a wholehearted, global response requires that we ourselves outgrow our immaturities. If protecting the biosphere is the largest cause humans have yet taken on, then it requires a vision of humanity that is equally big, and a psychological and introspective understanding that is adequate to the scale of the challenge.

Such a challenge would alert ecology to modern psychology, and to humankind's perennial search for meaning. These inquiries reveal a human interior capable of profound refinements in compassion, ecological awareness and adaptive intelligence.

Biology, ecology and taxonomy are important because they can deliver scientific truth. But they do not guarantee that we will use that truth wisely. If anywhere, the impediment lies within us all.

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The Australian Plant Census: the other APC

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The Australian Plant Census (APC) is an ambitious project to produce a unified, agreed list of scientific names for all native and naturalised vascular plants occurring in Australia. The census will eventually account for every name used in the Australian taxonomic literature, including synonyms and phrase names, and provide information on the taxonomic concepts followed. A list of the States and Territories in which the taxon occurs is also included.

Problems have arisen in the past with botanists and state herbaria using different concepts when applying names to their flora, with plants seemingly 'changing names at state borders'. The need for an agreed list of consistently applied names was highlighted as the Commonwealth tried to align its legislative schedules for the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) with lists used by the states in their own legislation. The advantage of the APC over previous attempts at a national census is that all decisions are made with extensive input and consultation from botanists in all state herbaria, making it a truly national, collaborative project.

In 2004 the Council of Heads of Australasian Herbaria (CHAH), representing the Heads of all the State, Territory and Commonwealth herbaria, agreed to produce this much needed list with funding from the Natural Heritage Trust. Initially it was referred to as the 'Consensus Census' as its aim is to present the majority (consensus) view, which in some cases will be a compromise between conflicting scientific opinions. The APC project is coordinated through the Australian National Herbarium in Canberra, part of the Centre for Plant Biodiversity Research which is jointly managed by CSIRO and the Department of Environment and Water Resources (DEW) through the Australian National Botanic Gardens. APC is maintained as a dynamic database, constantly updated as new information becomes available.

The Australian Plant Census is accessible to scientists and the public during its development, although it should be noted that not all families have yet been treated (completed families are indicated on the APC website). All EPBC Act listed taxa and some large groups such as the Proteaceae, Chenopodiaceae and Mimosaceae have been completed; many major groups remain to be tackled by the project, including the Poaceae, Fabaceae, non-eucalyptoid Myrtaceae and Asteraceae.

The census team genuinely welcomes corrections or feedback on the project – please feel free to contact us via cpbr-info@anbg.gov.au.

The APC is available: http://www.chah.gov.au/apc

The Katherine Sorghum – a big grass with a very small distribution

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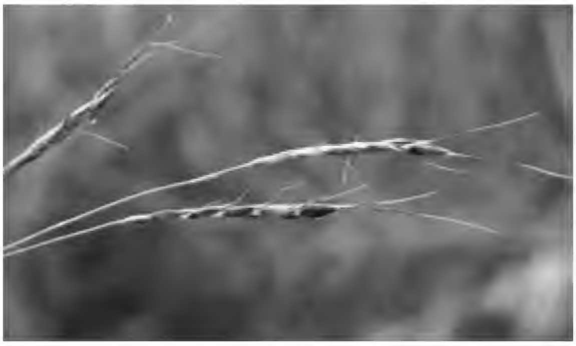
Katherine Sorghum, *Sorghum macrospermum*, is a large annual grass and is thought to be found only within a 30 km radius of Katherine township in the Northern Territory (Lazarides *et al.* 1991). The Katherine Sorghum is a little studied species and is interesting because of its large physical and seed size, and because of its seemingly specific habitat requirements. The grass grows to a height of 4 metres and has the largest seed of any native Sorghum. In contrast to most indigenous Sorghums, such as *S. timorense*, that are widely adaptable (Lazarides *et al.* 1991), *S. macrospermum* is thought to be found only in limestone or karst outcrops in and around Katherine (Cowie, Crothers, Crowder and Saggers pers. comm. 2007). A pilot survey conducted during the wet season in early 2007 confirmed the limestone terrain association and raised further questions about habitat variables impacting this species.

Karst Limestone

The Katherine region contains many distinct geographic formations; one of these is the Tindal Limestone and aquifer. The Tindal Limestone has extensive areas of karst terrain, a distinctive grey, soluble carbonate rock that breaks through the soil surface. Karst landscapes are shaped when water becomes weakly acidic and dissolves limestone. The dissolving actions of water on the limestone bedrock result in distinctive landscapes such as sinkholes, caves, exposed ridges, towers, pavements and pinnacles.



The Katherine Sorghum. Photo: Russell Shaw

Around Katherine Township these various formations vary greatly in size from a few square metres to around 100 hectares. Current estimates suggest that there are about 60 areas that contain various types of surface outcrops of karst formations, all within 30 km of Katherine. The little information that is available points towards the outcrops being local biodiversity hotspots.

The habitat of Katherine Sorghum

A basic survey for Katherine Sorghum was undertaken. The approach was twofold: firstly, a broad scale general comparison of karst terrain versus nearby woodlands and secondly, a microhabitat survey of vegetation variables within various karst formations only. The broad scale survey included random searching for Katherine Sorghum within a 30 km radius of Katherine. This search was to determine broadly where Katherine Sorghum occurred and included woodland, sandstone and riparian habitats as well as karst limestone. Basic soil tests were also conducted from both woodland and karst areas to compare characteristics. The karst habitat survey used a randomly thrown one-metre square quadrat to gain an understanding of grass types within karst terrain. Variables recorded were, presence/absence of *S. macrospermum*, other grasses & forbs, karst coverage, vegetation coverage, slope and surrounding karst form. The quadrat was thrown 60 times over 5 sites.

Despite extensive surveying no evidence of *S. macrospermum* was found outside of karst habitat. This survey backed up previous reports of marked vegetation differences between karst outcrops and nearby woodland (Parks and Wildlife Commission of the Northern Territory 2000). More extensive surveying may result in this species being located in other non-karst limestone habitats, but locally based experts express doubt (Crowder and Saggers pers. comm. 2007). Interestingly, there were large and obvious differences between soil from karst terrain and woodlands. Total organic matter in karst terrain was 17% compared to 1.4 to 1.8% in nearby woodlands, Calcium was 10 to 30 times higher in the karst than in woodlands (6140 versus 184–590 ppm). Available nitrogen, phosphorus and potassium were also far higher in the karst: N 15.1 versus 3.8, P 140 versus 6 and K 296 versus 93. While these results are not statistically significant due to the low sample numbers they were nonetheless thought provoking.

The vegetation communities within karst terrain were varied, with monsoon vine thickets (with *Ficus platypoda, F. virens, Mallotus nesophilus, Croton arnhemicus, Lysiphyllum cunninghamii, Grewia breviflora* and *Celtis*

Karst landscape near Katherine, habitat of the Katherine Sorghum. Photo: Matt Daniel

philippinensis) at some sites and open low woodland on others (with *Eucalyptus tectifica, Cochlospermum fraseri* and *Lysiphyllum cunninghammii).* The monsoon vine thicket occurred primarily around the edges of caves and sinkholes.

Occurrence of Katherine Sorghum within karst outcrops

The number of *S. macrospermum* varied between 0 and 412 per square metre. At several sites where the terrain consisted of dense karst pinnacles no *S. macrospermum* was observed in quadrats or by active searching. Sites containing karst boulder and rubble scree on ridges or karst pavement ridges had varying amounts of *S. macrospermum.*

Lazarides *et al.* (1991) suggested that *S. macrospermum* is probably highly palatable to stock and feral herbivores due to a lack of tannin-like substances. In support of this, this survey found no evidence of *S. macrospermum* in highly grazed and weed-infested areas. The karst limestone may provide a sheltered habitat for the Katherine sorghum. This may be due to karst soil moisture or chemistry, shelter for seed from predators, inaccessible terrain making access difficult for large herbivores. Whilst fire regimes appeared to influence the tree and shrub vegetation structure and species it did not seem to influence the occurrence of *S. macrospermum* at the survey sites.

Seed of Katherine Sorghum. Photo: Sam Crowder

Threats and challenges

Much of the karst limestone, and as a consequence *S. macrospermum*, is located on private land. Local grass gurus cite grazing and subdivision as the main threats to this unique grass (Crowder and Saggers pers. comm. 2007). Some other threats appear to be:

- clearing vegetation to attempt production;
- inappropriately planned development/growth – large areas of karst have been subdivided for housing blocks;
- accelerating sinkhole development by changing surface water flows by vegetation clearing, bulldozing karst or structural disturbance;
- weed infestation such as by Sabi (*Urochloa mosambicensis*), Annual Mission Grass (*Pennisetum pedicellatum*), Neem (*Azadirachta indica*), Rubber Bush (*Calotropis gigantea*), Balsam Pear (*Momordica charantia*), Grader Grass (*Themeda quadrivalis*) and Wandering Jew (*Ipomoea triloba*);
- large hot fires killing figs and other monsoonal type vegetation; and
- pollution – contaminants travel readily and with little natural filtration in karst systems; for example, if a truck transporting cyanide rolls into a karst sinkhole, the aquifer will be contaminated.

A handbook for managing karst country

In the course of this preliminary survey, interested people pointed out that a number of both described and undescribed vertebrate and invertebrate species are dependent on karst habitats. These include two species of shrimp which live in the karst aquifer. These animals, which live permanently in the ground water, are called stygofauna and are unique. Little is known about the diversity and distribution of these animals. There are also at least four undescribed land snails found in karst around Katherine. Bats, rats and wallabies also seem to find refuge in these areas. Most landholders are interested in the 'special' plants and animals found in their karst terrain and are joining in with future planned survey and monitoring work. An identified need is to develop with landholders a 'handbook for managing your karst country', to address the specific land ownership challenges. A survey of fauna and flora, including stygofauna, as well as karst formation location, size, type, condition and monitoring of water quality in sinkholes will be a part of future development of this handbook.

Acknowledgments

Thanks to Michael Crothers, Sam Crowder and Boronia Saggers from Greening Australia Katherine office and Ian Cowie from the NT Herbarium.

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Successful augmentation of an *Acacia whibleyana* (Whibley Wattle) population by translocation

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Acacia whibleyana (Whibley Wattle) is a nationally endangered wattle, extremely restricted in distribution, with a small population size and showing little sign of natural regeneration in the wild. Its fragmented distribution along road corridors and in small, isolated scrub patches near Tumby Bay on south-eastern Eyre Peninsula renders it susceptible to a greater range of threats than may exist in more pristine habitats. Present threats include habitat disruption through modified soil properties and salinity levels, altered fire regimes, small population sizes affecting reproductive outputs and genetic resilience, and introduced weeds, diseases and herbivores affecting existing plants and their regenerative capacity (Freebairn & Pobke 2007).

Whibley Wattle is found in only two small disjunct population centres (Salt-lake scrub and Quarry scrub populations) about 15 km apart. A few plants also occur on roadsides in the vicinity of these two population centres. Roadsides are 5 m wide and generally more weedy than the spatially larger Salt-lake (~ 0.8 ha) and Quarry (~ 0.3 ha) scrub populations.

Figure 1. Acacia whibleyana *seedling at time of transplanting in 1996. Photo: Manfred Jusaitis*

The Salt-lake population has declined from 107 wild plants recorded in 1995 (Jusaitis 2002) to 99 plants in 2007 (Jusaitis, unpublished), a 7.5% reduction over 12 years. This decline occurred despite fencing of the main population in 1995 to exclude rabbits, stock and vehicular traffic, and despite some weed control being undertaken in 1997 (Freebairn & Pobke 2007). Losses resulted from mortality of aged plants that were already mature at the time of the original survey in 1995. It appears that the age distribution of Whibley Wattles is heavily weighted in favour of older individuals, and that recent recruitment, particularly on roadsides, is negligible (Jusaitis 2005). This is potentially due to inadequate disturbance regimes required to trigger germination, and to competitive influences of annual weeds on seedling establishment (Yates & Broadhurst 2002, Jusaitis 2005).

The narrow nature of road verges and the small size of remnant patches of Whibley Wattle, all of which adjoin arable farming land, render it difficult to prescribe burning as a recovery tool to rejuvenate these populations. Moreover, burning is likely to further enhance weed invasion of roadside remnants (Milberg & Lamont 1995). Thus the decision was made to augment and reinvigorate the Salt-lake scrub population by translocation of Whibley Wattle seedlings to the site. This report outlines the progress of this successful translocation over a 10-year period.

Translocation methods

Seedlings were raised from seed collected in 1995 from the Salt-lake scrub, and were 10 months old (average height 60 mm) at the time of transplanting from 100 ml propagating tubes (Fig. 1). On 19 June 1996, two replicates of 19 seedlings in each, and a third replicate of 20 seedlings were planted along a disused track at the Salt-lake scrub site (soil pH=6.4±0.1; electrical conductivity=4.4±0.6 mS/cm). The site was weed-free, but the soil was compacted from past vehicular traffic. Plant survival was monitored, and height of the longest fully extended shoot was measured on regular visits to the site. Mean height and survival were plotted over time.

Translocation results

Transplants grew by over 500% of their original height during their first two years and were approaching 1 m in height by their fifth year (Fig. 2). Whibley Wattle shows

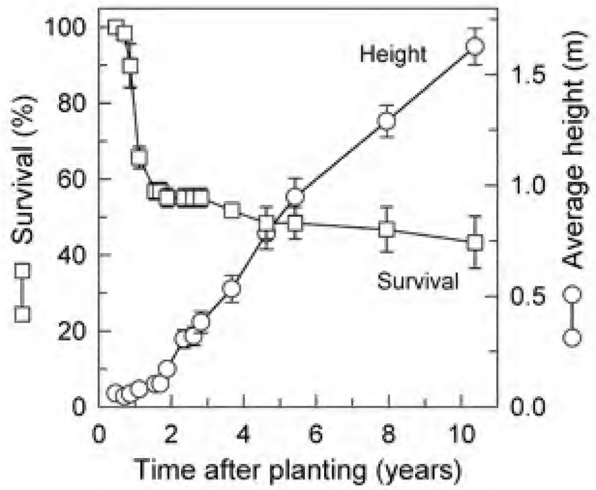

Figure 2. Mean Survival and height over time of 58 Acacia whibleyana *plants translocated at the Salt-lake scrub in June 1996. Vertical bars represent the standard error (SE) of the mean. Time (0) corresponds to 1 January 1996.*

the typical characteristics of a Type III survivorship curve – extremely heavy juvenile mortality, but those individuals that do survive have a relatively high expectation of future continued existence (Deevey 1947). The largest and most immediate decline in survival occurred over the first summer, during which 43% of transplants died as a result of falling soil moisture levels. Only 55% of plants survived to 2 years. Subsequently, as root systems became further established, mortality declined and 43% of transplants still remain alive after 10 years.

Survival over the first year may be improved by using additional water-saving horticultural techniques such as mulches, hydrogel granules or irrigation. However, Monks and Coates (2002) found little effect of supplementary watering and mulching on survival or growth of *Acacia aprica* and *A. cochlocarpa* seedlings. They reported that 30–100% of transplants remained a year after translocation, survival varying with year of planting and protection from herbivory.

There was no evidence of herbivore grazing damage to translocated Whibley Wattle at the Salt-lake scrub site. Surviving plants first flowered and set fruit in August 1999, during their third year of growth. Flowering and seed set have occurred annually after that, significantly augmenting the soil seed bank.

Of the original 58 seedlings transplanted in 1996, 25 have become established and survive after 10 years. This amounts to a 25% increase in the wild population of Whibley Wattle at the Salt-lake (Fig. 3). Since this translocation commenced, its success has encouraged several more translocations to be undertaken along roadsides and on private land to further augment Whibley Wattle numbers in both the Salt-lake and Quarry populations. With the assistance of students and staff of the Tumby Bay Area School under the supervision of the local Threatened Flora Officer, Landcare Officer and Bush Management Advisor, further translocations were undertaken between 2003 and 2006 (Freebairn & Pobke 2007). Their long term aim has been to rejuvenate, stabilise and interconnect Whibley Wattle population fragments to produce a stable and sustainable metapopulation.

Acknowledgements

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Figure 3. The Salt-lake translocation site one year after planting Acacia whibleyana *(top) and 10 years after translocation (bottom). Photos: Manfred Jusaitis*

Florabank – information on Australian native seed

Penny Atkinson

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Florabank, Australia's valued native seed resource, has been revived after a long dormancy period – just like a hardy native seed. Using the latest web technology, the new Florabank website http://www.florabank.org.au will provide an updated contact directory for people in the seed industry, seed references and resources, and an extensive database of information about native seed. The website will also provide on-line forums to bring people interested in native seed together to discuss ideas and share knowledge.

Eucalyptus macrocarpa *seed capsules. Photo: Florabank*

Information

The Florabank database will contain information about germination, dormancy, collection time and methods, for thousands of Australian native species. The database will identify, gather and host existing information about Australian native seed and make it accessible to seed practitioners.

Florabank is funded by the Australian Government through the Natural Heritage Trust, and is delivered by a partnership between Greening Australia, Ensis and Agtech Pty Ltd. Florabank aims to increase the availability of good quality native seed for large scale revegetation projects in Australia.

Access to good information about seed will enable more efficient use of seed, as seed practitioners will be able to collect, store and manage seed appropriately to maximise viability and genetic quality. This will, in turn, enable more species to be available for revegetation projects, because one of the factors limiting the number of species for these projects is the availability and viability of seed. By making this information available through the database, people using seed can learn about and employ new techniques to reduce the amount of seed required and store it correctly so it doesn't lose viability.

Acacia *seed and pods. Photo: Florabank*

Contribute to the Florabank Database

The database will initially host seed data from the Floradata project (which alone covers 5200 Australian species) and the Australian Tree Seed Centre. Florabank would also like to collaborate with other organisations and seed researchers to make this database as comprehensive as possible. Data contributions (which can also include images) will be fully acknowledged with links to the data source. Contributors will be able to register to the Florabank site and enter information into the database for their own species of interest.

The Florabank website will also feature:

- locally and regionally adaptable decision support tools for the native seed industry;
- access to current references, web-links and resources about native seed; and
- forums where people can ask and answer questions, and raise seed-related issues for discussion.

For the future Florabank is also developing a seed-trading portal where people looking for seed will be able to source it from registered seed providers.

Florabank Training

Florabank is providing professional development training to people working in the native seed industry. Florabank training covers recent research and in-depth knowledge about physical and genetic seed quality, provenance, and seed collection, storage and management techniques. The course is held over three days with an optional fourth day field trip, and assessment is workplace-based. Successful participants will receive a Florabank Certificate, and will be able to use Florabank endorsement for their seed. They will also be eligible for credit for a VET Certificate III unit, 'Manage Seed Collection'. The Florabank course covers significant additional material

to that covered in the Certificate III unit, particularly in relation to the genetics and provenance of seed. Courses will be held in six states between now and mid-2008, with the first course in Queensland in October 2007.

Why is good quality seed so important?

By providing our seed information services, Florabank will be enabling more revegetation with greater numbers of species and higher genetic diversity of revegetated populations. Plants grown from seed which has been properly collected, stored and managed will be more likely to survive to reproduce, and will contribute to the conservation of our flora's genetic diversity in our changing world.

For more information

Contact Penny Atkinson (Florabank coordinator) at general@florabank.org.au or call 1300 886 589 and ask for Florabank, or see http://www.florabank.org.au.

Seeds germinating. Photo: Florabank

Report from New Zealand Plant Conservation Network

Bec Stanley

Email: rebecca.stanley@arc.govt.nz

New Zealand's MWH threatened plant seed bank ready to receive seed

A seed bank for New Zealand's threatened plants, supported by MWH New Zealand (engineering and environmental consultants), is now ready to receive seed for long-term storage. A registration process for prospective seed collectors and protocols for seed collecting has now been added to the NZPCN's website under the 'Conservation info' section. The priority for collection is acutely threatened species, including those that are taxonomically indeterminate. The seed bank will act as an insurance against the extinction of these species in the wild. The seed collecting guidelines on the NZPCN's website provide information on how to collect seed, what data to record for each collection and where to send seed to.

Fact sheets for indigenous New Zealand orchids and wetland monocots completed

Factsheets are now available on the NZPCN website for all 104 formally recognised indigenous orchids and 18 indigenous cyperaceous genera from New Zealand. A range of botanical experts have donated their time and expertise to prepare factsheets. The factsheets on the web continue to be an excellent resource for the public and for local councils who advocate the site to community groups and landowners they work with.

View the factsheet of the pixie cap orchid, Acianthus sinclairii, *on the NZPCN website at: http://www.nzpcn.org.nz/vascular_plants/detail.asp?PlantID=1486. Photo: Bec Stanley*

Advocating the Network

John Sawyer, secretary of the NZPCN, recently presented a talk on the role of the network in plant conservation in New Zealand at the Conserv-Vision Conference. This conference celebrated 20 years of work by the Department of Conservation, which is the lead government agency for plant conservation in New Zealand. Papers on plant topics were also presented by network members including Andrea Brandon, a Department of Conservation botanist who talked about the efficacy of regional plant strategies. Peter Buchanan from Landcare Research discussed New Zealand's rare fungi (acknowledging their rightful taxonomic place as nearer to animals than plants) which are also listed, illustrated and described on the NZPCN website.

View *Trilepidea*, the E-Newsletter of the New Zealand Plant Conservation Network:

May 2007
http://www.nzpcn.org.nz/documents/Trilepidea-42-070515.pdf

June 2007
http://www.nzpcn.org.nz/documents/Trilepidea-43-070618.pdf

July 2007
http://www.nzpcn.org.nz/documents/Trilepidea-44-070712.pdf

An archive of *Trilepidea* is at: http://www.nzpcn.org.nz/newsletter_publications/newsletter_archive.asp

To join the New Zealand Plant Conservation Network, go to: http://www.nzpcn.org.nz/how_to_join/index.asp

Research Roundup

Bowman, D.M.J.S., Franklin, D.C., Price, O.F. and Brook, B.W. (2007). **Land management affects grass biomass in the *Eucalyptus tetrodonta* savannas of monsoonal Australia.** *Austral Ecology* 32(4): 446-452.

Broadhurst, L. and Young, A. (2007). **Seeing the wood and the trees – predicting the future for fragmented plant populations in Australian landscapes.** *Australian Journal of Botany* 55(3): 250-260.

Brundrett, M. (2007). **Scientific approaches to Australian temperate terrestrial orchid conservation.** *Australian Journal of Botany* 55(3): 293-307.

Coates, D.J. and Dixon, K.W. (2007). **Current perspectives in plant conservation biology.** *Australian Journal of Botany* 55(3): 187-193.

Coates, D.J., Sampson, J.F. and Yates, C. (2007). **Plant mating systems and assessing population persistence in fragmented landscapes.** *Australian Journal of Botany* 55(3): 239-249.

Cochrane, J.A., Crawford, A.D. and Monks, L.T. (2007). **The significance of *ex situ* seed conservation to reintroduction of threatened plants.** *Australian Journal of Botany* 55(3): 356-361.

Guerrant Jr, E.O. and Kaye, T.N. (2007). **Reintroduction of rare and endangered plants: common factors, questions and approaches.** *Australian Journal of Botany* 55(3): 362-370.

Keith, D.A., Simpson, C., Tozer, M.G. and Rodereda, S. (2007). **Contemporary and historical descriptions of the vegetation of Brundee and Saltwater Swamps on the lower Shoalhaven River floodplain, southeastern Australia.** *Proceedings of the Linnean Society of N.S.W.* 128: 123-155.

Kirkpatrick, J.B. (2007). **Collateral benefit: unconscious conservation of threatened plant species.** *Australian Journal of Botany* 55(3): 221-224

Merritt, D.J., Turner, S.R., Clarke, S. and Dixon, K.W. (2007). **Seed dormancy and germination stimulation syndromes for Australian temperate species.** *Australian Journal of Botany* 55(3): 336-344.

Symon, D.E. (2007). **Lists of gypsophilous plants from southern Australia.** *Journal of the Adelaide Botanic Gardens* 21: 45-54.

Wardell-Johnson, G.W., Lawson, B.E. and Coutts, R.H. (2007). **Are regional ecosystems compatible with floristic heterogeneity? A case study from Toohey Forest, south-east Queensland, Australia.** *Pacific Conservation Biology* 13: 47-59.

Ye, Q., Bunn, E., Krauss, S.L. and Dixon, K.W. (2007). **Reproductive success in a reintroduced population of a critically endangered shrub, *Symonanthus bancroftii* (Solanaceae).** *Australian Journal of Botany* 55(4): 425-432.

Information Resources and Useful Websites

Some of the resources and websites listed here have been noted in previous issues, but all are on the theme of 'Taxonomy and Plant Conservation'.

Taxonomy and Plant Conservation

E. Leadley and S. Jury (eds)
Cambridge University Press, Cambridge, 2006

This volume consists of 21 chapters by a variety of authors around the theme of the critical role played by taxonomy in the conservation and sustainable use of plant diversity. The book is a tribute to British plant taxonomist and conservationist Vernon Heywood. It has a European focus, but covers a range of issues that are of general relevance. Some chapters provide succinct introductions to topics such as principles and practice of plant taxonomy; chemosystematics and plant conservation; measuring diversity; and molecular systematics for measuring and monitoring plant diversity. Other chapters deal with plant taxonomy in relation to reintroduction, seed banks and conservation of taxonomically difficult plant groups. The contribution of Botanic Gardens to plant conservation is touched on in several chapters. A chapter on conservation of island floras has some intriguing section headings such as 'Everything is vague to a degree that you do not realize until you have tried to make it precise' [this in relation to species boundaries]. The book concludes with a chapter on 'Good networks: supporting the infrastructure for taxonomy and conservation'. ISBN 0521845068 (hardback), 0521607205 (paperback). 366 pages. RRP £70.

The Families of Flowering Plants of Australia An Interactive Identification Guide (Revised Edition)

K.R. Thiele & L. G. Adams (eds)
CD ROM, Australian Biological Resources Study/
CSIRO Publishing, 2002
http://www.environment.gov.au/biodiversity/abrs/publications/cds/flowering.html

This CD ROM is an interactive identification guide for all of the plant families in Australia. It enables the user to quickly and easily identify a plant to family level, learn about Australia's plant families and is illustrated with over 1500 photographs or drawings.

EUCLID - Eucalypts of Australia (3rd Edition)

Centre for Plant Biodiversity Research
DVD, CSIRO Publishing, 2006
http://www.publish.csiro.au/pid/5401.htm

EUCLID is the definitive electronic identification and information system for Australian eucalypts, which has been expanded to include northern Australia - a total of 894 taxa. It covers the morphology and some geographic and ecological information. Fact sheets include botanical description, common name, the formal scientific name and nomenclatural synonyms, geographic and ecological information, and notes covering relationships, distinguishing features and other species it might be confused with. Includes distribution maps and 9000 high quality colour images, illustrating the main features of each plant.

Australian Network for Plant Conservation - Internet Resources Directory

http://www.anpc.asn.au/web.html

The Internet Resources Directory on your own ANPC website links to many resources and databases, including the following list of botanical databases.

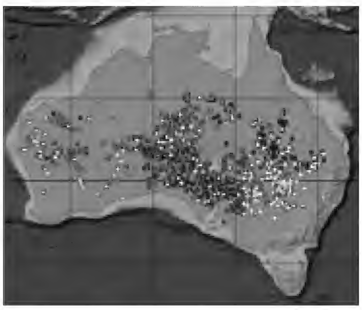
List of botanical databases

http://www.environment.gov.au/land/publications/botanical-information/appendices.html

This list of botanical databases was prepared by CSIRO Plant Industry for Environment Australia. It included national, state, herbarium and specialised databases. It was prepared July 2003, and while it has not been updated, it is still useful.

Australia's Virtual Herbarium (AVH)

http://www.chah.gov.au/avh/avh.html



Distribution map of Acacia aneura *(Mulga) from AVH. Different symbols represent the various herbaria holding the 2755 specimens of this species which are mapped.*

AVH is an on-line botanical information resource. It provides immediate access to the wealth of data associated with scientific plant specimens in each of the major Australian herbaria. The several million specimen records are accessible as distribution maps of individual species. Search AVH at *http://www.chah.gov.au/avh/index.html*

Australian National Herbarium (ANH) – Centre for Plant Biodiversity Research

http://www.anbg.gov.au/cpbr/herbarium/index.html

The Australian National Herbarium contains more than 1 million specimens of plants and fungi. Information recorded at the time of collection (date, locality, conditions under which the plant is growing, who collected it) has been entered onto the Herbarium's computer database. The information provides an invaluable resource about our biodiversity and is now a significant component of Australia's Virtual Herbarium, a project to make herbarium information readily available through the Internet. The ANH website provides links to many related sites.

The Australian Plant Name Index (APNI)

http://www.anbg.gov.au/cgi-bin/apni

APNI is a key source for the *Australian Plant Census* and provides nomenclatural information on names of all Australian plants.

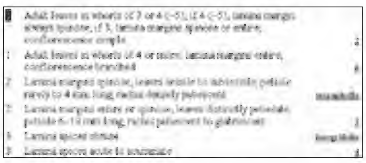
The International Plant Names Index (IPNI)

http://www.ipni.org/index.html

IPNI is a database of the names and associated basic bibliographical details of all seed plants, ferns and fern allies. The data, contributed by members of the botanical community, are freely available and are gradually being standardized and checked. IPNI is the product of a collaboration between The Royal Botanic Gardens, Kew, The Harvard University Herbaria, and the Australian National Herbarium.

The Australian Biological Resources Study (ABRS)

http://www.environment.gov.au/biodiversity/abrs/online-resources/flora/index.html



Section from on-line key to species of Macadamia *in treatment from electronic version of* Flora of Australia

ABRS provides online delivery of taxonomic and biological information on species known to occur in Australia. It provides an array of information resources including checklists, descriptive information and censuses of various groups of organisms, searchable electronically. ABRS is also responsible for publication of the Flora of Australia, some volumes of which are accessible electronically (http://www.environment.gov.au/biodiversity/abrs/online-resources/flora/main/).

Australian Plant Census

http://www.anbg.gov.au/chah/apc/introduction.html and http://www.chah.gov.au/apc/

The Australian Plant Census is a collaborative project to produce a consensus view of the vascular plant taxa recognised as occurring in Australia. This Census is endorsed by the Council of Heads of Australasian Herbaria (CHAH) and is an integral part of the Australian Plant Name Index. See article on p. 20.

BGCI publications feature taxonomy

Two recent Botanic Gardens Conservation International (BGCI) publications feature taxonomy, in celebration of the 300th anniversary of the birth of Linnaeus, the 'father of taxonomy'.

The January 2007 issue of ***BGjournal*** includes articles on the theme 'Taxonomy and plant conservation: the tercentenary of the birth of Carl Linnaeus', including:

- The legacy of Linnaeus.
- Taxonomy and Plant Conservation.
- Taxonomy is the tool that measures plant diversity - and our level of knowledge.
- The Catalogue of Life: indexing the world's species.

The issue also includes an extensive list of books and other resources related to taxonomy.

Roots is the BGCI education review, and issue 4(1) for April 2007 contains a number of articles on theme 'Linnaeus: still relevant 300 years on?', including:

- Is it an apple? Is it a pear? Who knows?: makes a case for the contemporary relevance of taxonomy in relation to forensics, the identification of poisonous plants and fungi and the search for new medical compounds and everyday products.
- Linnaeus as a teacher.
- We shall always need taxonomists.
- Taxonomy for horticulture students: at RBG Edinburgh students learn taxonomy from living plants.
- Systematic education and interpretation: changes to the arrangement of living collections at Utrecht University Botanic Garden have been made to reflect recent insights about the relationships of plant families from molecular analyses.

Roots also includes regular articles on practical activities for teaching about plants and conservation, and in this issue Merilyn Haigh (Gladstone Tondoon Botanic Gardens) discusses hands-on activities as a way of 'Teaching children using the essence of nature'.

ANPC Conference and Workshop

Workshop on identifying plants of grassy ecosystems of the ACT region

Thursday 22 - Friday 23 November, 2007
Canberra

Objectives

- To improve skills in identifying plants of grassy ecosystems of the ACT region.
- To learn to recognise species which indicate quality or conservation significance of the site.

Who is it for?

This workshop is for anyone wanting to identify local plants in the field. Most people will be from the ACT and surrounding region, though others will be welcome. Numbers will be limited by the number of skilled tutors available.

Workshop outline

The workshop will be on two consecutive days, mostly field-based:

- Day 1: for beginners and those less experienced;
- Day 2: for those with more experience.

Participants can register for one or both days. Some day 1 participants may wish to further develop their skills by also registering for day 2.

Tutors skilled in plant identification are being sourced from across the ACT and local region. Workshop participants will break into groups and will move between habitats and tutors during the day.

Support

The following groups are generously providing in-kind support: the Centre for Plant Biodiversity Research, the Australian National Botanic Gardens, NSW Department of Environment and Climate Change, ACT Government (Parks, Conservation and Lands), Greening Australia (Capital Region), Friends of Grasslands (FOG).

The workshop is also supported by the following community-focused groups: the Southern Tablelands Grassy Ecosystem Conservation Management Network (CMN), Ginninderra Catchment Group, Southern ACT Catchment Group, Molonglo Catchment Group, Southern Tablelands Ecosystems Park (STEP), Monaro Grasslands Conservation Management Network (CMN).

Registration

Registration for this workshop will open early September. Notification will be sent via the ANPC email list and will also be posted on our website once details have been finalised. Registration fees have yet to be determined. Catering, transport and support materials will be included in the fee.

ANPC 7th National Conference
Our declining flora – tackling the threats

PUT THIS IN YOUR DIARY NOW!

21 –24 April 2008
Location: Mulgoa NSW (near Penrith, western Sydney).

The ANPC and Mount Annan Botanic Garden invite you to a conference on threatening processes in plant conservation. Papers and suggestions for workshop topics are also invited.

For more information, see the back cover of this issue.

Contact the ANPC Office for further information on the workshop or conference

Phone: 02 6250 9509
Email: anpc@anpc.asn.au
Web: http://www.anpc.asn.au

Eryngium ovinum *(Blue Devil) is widespread throughout temperate woodlands and grasslands.*
Photo by Rainer Rehwinkel

Conferences and Workshops

MEDECOS XI 2007
International Mediterranean Ecosystems Conference

2-5 September 2007, Perth, Western Australia

The program for MEDECOS XI will feature oral and poster presentations covering important contemporary topics of global interest (eg global change, conservation of threatened species and ecosystems, restoration ecology). Given Perth's location in a global biodiversity hotspot, the accompanying pre-and post-conference field trips will showcase some of Western Australia's unique flora and fauna, ancient landscapes and striking coastline.

The following themes will be addressed:

- Defining a Mediterranean Ecosystem
- Species and Population Ecology
- Landscape Ecology
- Socio-Cultural Dimensions
- Global Change
- Disturbance Ecology
- Invasive Species
- Ecophysiology
- Conservation of Threatened Species
- Conservation of Ecosystems
- Restoration Ecology

For information, see http://www.medecosxi2007.com.au. The organising committee can be contacted via medecosxi2007@bgpa.wa.gov.au.

International Society for Seed Science Meeting
Seed Ecology II

9-13 September 2007, Perth, Western Australia

Seed Ecology and its many facets (such as dispersal, predation, seed banks, dormancy, germination) continues to be a growth area in plant restoration. Seed Ecology II provides a venue for seed practitioners to meet as a single research community, and will be of particular value to students and young scientists. The meeting will also foster cooperation between scientists from different countries and lead to closer integration between researchers working on specific aspects of seed ecology.

The latest and most exciting developments in seed ecological advances will be showcased, around the following topics:

- Advances in Seed Dormancy and Germination
- Dispersal Ecology
- Conservation and Restoration Seed Ecology
- Soil Seed Bank Dynamics
- Applied Seed Ecology

See: http://www.seedecology2007.com.au.

9th International Conference on the Ecology and Management of Alien Plant Invasions

17-21 September 2007, Hyatt Regency Hotel, Perth, Western Australia

This conference is organised by The Weeds Society of WA (Inc.) and is aimed at all those who are interested in invasive plants in natural areas.

The conference will cover topics such as:

- ecological, biological and biogeographical studies on invasive plants;
- the management of plant invasions;
- the development of multidisciplinary activities focussed on prevention of new incursions and management of existing infestations;
- appropriate legislation, public education and information; and
- any other relevant aspects of plants that invade natural areas.

See: http://www.congresswest.com.au/emapi9

Australian Systematic Botany Society 2007 Conference – Australasian Plant Taxonomy

24-28 September 2007, Cazaly's Club Palmerston, Darwin, NT

Seminar presentations will be accepted on any topic in plant taxonomy and related subjects, including plant conservation and traditional uses of plants from Australia and the broader Australasian region.

The week's activities will include two days of seminars (24-25 September), a one-day field trip (exploring sites of botanical significance between Darwin and Katherine), and two concurrent workshops on Botanical Latin and Bryophytes (27-28 September).

Bryophyte Workshop – Conducted by David Meagher

Maximum of 20 people, $135 each (cost includes lunch)

This two-day workshop introduces the smallest members of the plant kingdom: mosses, liverworts and hornworts. Sessions will cover field equipment and collecting techniques, laboratory equipment and techniques, macroscopic and microscopic characters used to identify specimens, identification of a range of selected specimens using keys, and the curation and storage of specimens.

Botanical Latin Workshop – Conducted by Emma Short

Maximum of 20 people, $185 each (cost includes lunch)

This workshop is an introductory course to Botanical Latin suitable for complete beginners and those with an interest in its workings. The course will cover the application and grammar of botanical Latin with plenty of theory and worked examples. On completion you will have a basic understanding of declensions and cases of nouns, adjectives, adverbs, pronouns, and measurements. Emma is the Botanical Latin editor for *Australian Systematic Botany*.

Enquires regarding registrations and abstract submissions to Dale Dixon (08 89994512, dale.dixon@nt.gov.au).

Conferences and Workshops (continued)

14th Biennial NSW Weeds Conference

24 - 27 September 2007
University of Wollongong, NSW

The Program will include presentations, a trade display, field trips and practical demonstrations. There is also a free public seminar on 26 September: "Grow Me Instead".

For more information, program details and registration: http://www.weeds2007.com.au or Phone: 02 9368 1200; Email: weeds2007@iceaustralia.com

WILDCARE National Conference 2007
Volunteering for wild places, wildlife and cultural heritage

23-25 November 2007, Hobart, Tasmania

To celebrate our 10th Anniversary WILDCARE Inc. is inviting volunteers, volunteer organisations, foundations, NGOs, government agencies and their staff to a conference in Hobart in November.

WILDCARE is a not-for-profit, volunteer organisation whose members provide time, effort, intellect and funding to a myriad of projects and programs in reserve management, visitor services and community education for nature conservation (on both public and private land), rehabilitating and rescuing wildlife and supporting cultural heritage conservation, in partnership with state and local government and private landholders. WILDCARE is a keen promoter of cooperative partnerships with reserve managers, private landholders, wildlife managers and cultural heritage managers, with the aim of making a real difference in the real world. WILDCARE promotes sharing ideas, developing new approaches and lending a practical hand to others.

This conference presents the opportunity for volunteers, volunteer and other community organisations, volunteer program managers and staff from partner agencies to get together and take some time to build better ways to work together towards a healthy reserve system, a protected cared for and rehabilitated environment and wildlife (plants and animals), protected and cared for cultural heritage and sites and an educated and aware community.

Further information: Office@wildcaretas.org.au or visit http://www.wildcaretas.org.au

Ecological Society of Australia 2007 Conference
Adapting to Change:
Society - Environment - Science

25 - 30 November 2007, Perth Convention Centre,
Perth Western Australia

This conference will aim to explore the place of ecology and ecologists in our changing world. By highlighting three key elements – society, environment, and science – we want to broaden the debate about change, and explore the way we view, understand, manage and influence change. Can ecology play a more effective role in facilitating change in human societies? As the environment changes what is the role of ecology in understanding, managing and adapting to this change? And as the way science is done changes, and the way science is perceived by society changes, how does our own discipline of ecology need to adapt?

Keynote speakers include: Paul Ehrlich, Clive Spash, Ian Lowe, Robyn Williams, Rosemary Hill, Henry Nix and Michael Soule.

Symposia will include:

- Embedding an ecological approach in agricultural landscapes: a way forward
- Conserving biodiversity in species-rich temperate ecosystems
- Ecology in suburbia: Conservation of biota in urban isolates
- Linking ecology, landscape and people for a sustainable future
- Prescribed Burning: Now …And then?
- Monitoring Ecological Change
- Indigenous adaptive management of country: integrating Indigenous peoples' knowledge and practices for sustainability
- Genetic assessment of the effects of environmental change on mating and dispersal.
- Who, how, why? The role of the public in ecological science

See: http://www.ecolsoc.org.au/ESA2007Conference.htm

ANPC Corporate Members

ANPC acknowledges the support of the following corporate members

Albury City Council, NSW

Australian National Botanic Gardens, ACT

BHP Billiton Olympic Dam, SA

Botanic Gardens of Adelaide, SA

Brisbane Botanic Gardens, QLD

Centre for Plant Biodiversity Research, ACT

Christchurch Botanic Gardens, New Zealand

Department of Environment & Climate Change, NSW

Department of Environment and Conservation, WA

Dept of Sustainability and Environment, VIC

Institute of Food and Land Resources, VIC

Redland Shire Council, QLD

Roads and Traffic Authority NSW, NSW

Royal Botanic Gardens Melbourne, VIC

Royal Tasmanian Botanical Gardens, Tasmania

Sydney Olympic Park Authority, NSW

Wyndham City Council, VIC

ANPC Major Sponsors

GOLD SPONSORS

Australian National Botanic Gardens, ACT

OTHER SPONSORS

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NSW Environmental TRUST

Australian Government
Department of the Environment and Water Resources

Royal Botanic Gardens Melbourne

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

AUSTRALIAN Government envirofund



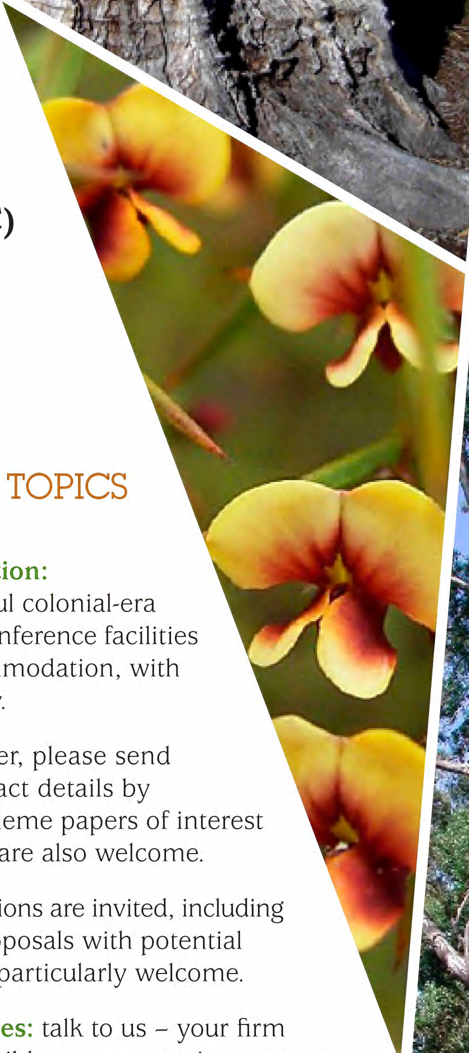
Our declining flora

TACKLING THE THREATS

Australian Network for Plant Conservation Inc (ANPC)

7th National Conference

Monday 21 – Thursday 24 April 2008
Location: Mulgoa NSW (near Penrith, western Sydney)




FIRST NOTICE & CALL FOR PAPERS AND WORKSHOP TOPICS

The ANPC and Mount Annan Botanic Garden invite you to a conference on threatening processes in plant conservation.

Threatening processes include human factors like land-clearing, fire mismanagement, and poor planning, geophysical ones like climate change, and biological ones like invasive weeds, animals and pathogens. They interact and operate at the smallest of local scales up to landscape level.

Tackling threatening processes is essential, whether for local patch preservation, threatened species management or whole-landscape protection. It requires pooling the best available science and practical experience.

This conference will bring together scientists, conservation managers and on-ground practitioners to demonstrate and discuss techniques for managing threats, share experience and identify knowledge gaps.

Papers, workshops and field trips will present the latest science and case studies from Australia and New Zealand.

Venue and accommodation: 'Winbourne' is a delightful colonial-era property, with modern conference facilities and budget-priced accommodation, with many alternatives nearby.

Papers: to present a paper, please send an abstract and full contact details by **15 February 2008**. Off-theme papers of interest to plant conservationists are also welcome.

Workshop topics: suggestions are invited, including off-theme. Developed proposals with potential presenters identified are particularly welcome.

Sponsorship opportunities: talk to us – your firm or organisation will be visible to conservation experts from across Australia and New Zealand.

Ancillary meetings: scope exists for meetings of allied organisations or interest groups within the conference - contact us to discuss.

Conference registration and accommodation cost: details available in November 2007, and preliminary program from 30 January 2008. In the meantime, to receive conference updates simply send the ANPC your contact details (by email to anpc@anpc.asn.au if possible) with subject "Conference".

Mount Annan Botanic Garden

Photos: Lotte von Richter, Mount Annan Botanic Garden.

Australasian Plant Conservation
BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

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